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Morinaga et al.

(10) Patent No.: US 9,146,637 B2
(45) Date of Patent: Sep. 29, 2015

(54) **MOBILE INFORMATION TERMINAL AND OPERATION STATE DETERMINATION METHOD**

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(73) Assignee: **NTT DOCOMO, INC.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 118 days.

(21) Appl. No.: **14/110,995**

(22) PCT Filed: **Jun. 20, 2012**

(86) PCT No.: **PCT/JP2012/065731**

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PCT Pub. Date: **Dec. 27, 2012**

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US 2014/0028604 A1 Jan. 30, 2014

(30) **Foreign Application Priority Data**

Jun. 24, 2011 (JP) 2011-140399

(51) **Int. Cl.**

G06F 3/041 (2006.01)
G06K 9/00 (2006.01)
G06F 3/01 (2006.01)
G06F 1/16 (2006.01)

(52) **U.S. Cl.**

CPC ***G06F 3/0414*** (2013.01); ***G06F 3/017*** (2013.01); ***G06K 9/00375*** (2013.01); ***G06K 9/00382*** (2013.01); *G06F 1/1684* (2013.01); *G06F 2203/04105* (2013.01)

(58) **Field of Classification Search**

CPC G06F 1/1626; G06F 3/0488; G06F 1/169; G06F 3/0414; G06F 3/016; G06F 3/04886; G06F 1/1684; G06F 21/316; H04M 2250/22

USPC 345/156, 173, 174, 619; 178/18.04; 715/764, 810, 863

See application file for complete search history.

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International Search Report Issued Sep. 18, 2012 in PCT/JP12/065731 Filed Jun. 20, 2012.

* cited by examiner

Primary Examiner — Koosha Sharifi-Tafreshi
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A mobile information terminal to determine whether a user's operation state is one-handed operation or two-handed operation. The mobile information terminal includes a pressure sensor array that acquires a gripping pressure distribution; a gripping pressure logger that records time-series changes in gripping pressure at each pressure sensor forming the pressure sensor array; a gripping pressure change point detection unit that includes a gripping pressure change amount calculation section that acquires time-series changes in gripping pressure at each pressure sensor and determines whether the amount of change in gripping pressure per unit time exceeds a predetermined value at any pressure sensor; and an operation state determination section that determines the operation state of the user of the mobile information terminal is one-handed operation when the amount of change in gripping pressure per unit time exceeds the predetermined value at any pressure sensor.

9 Claims, 28 Drawing Sheets

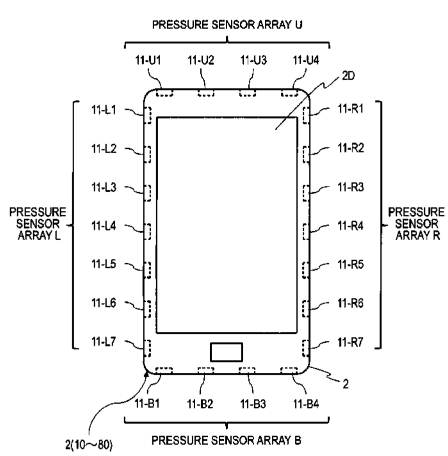


FIG. 1A

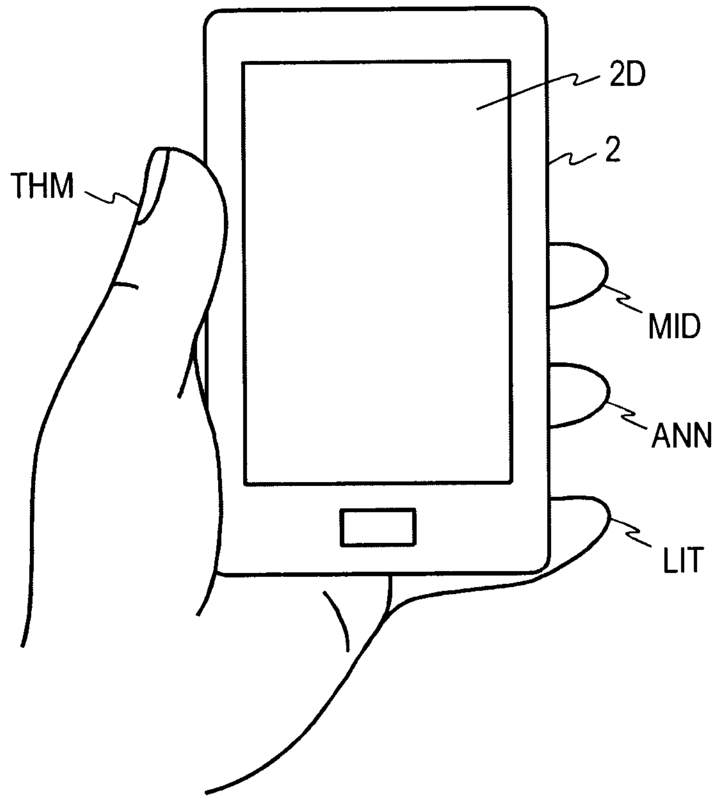


FIG. 1B

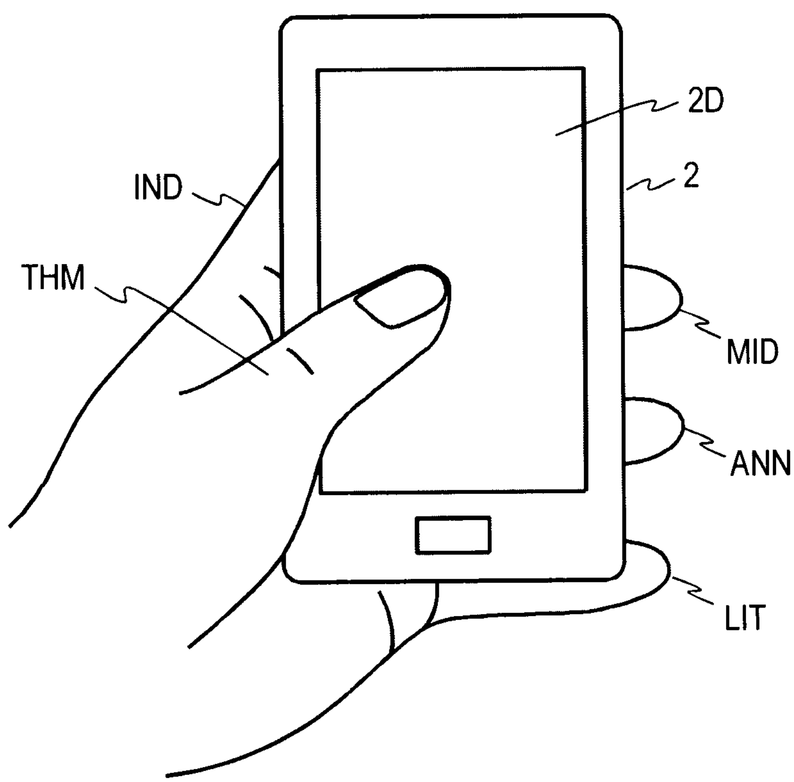


FIG. 2A

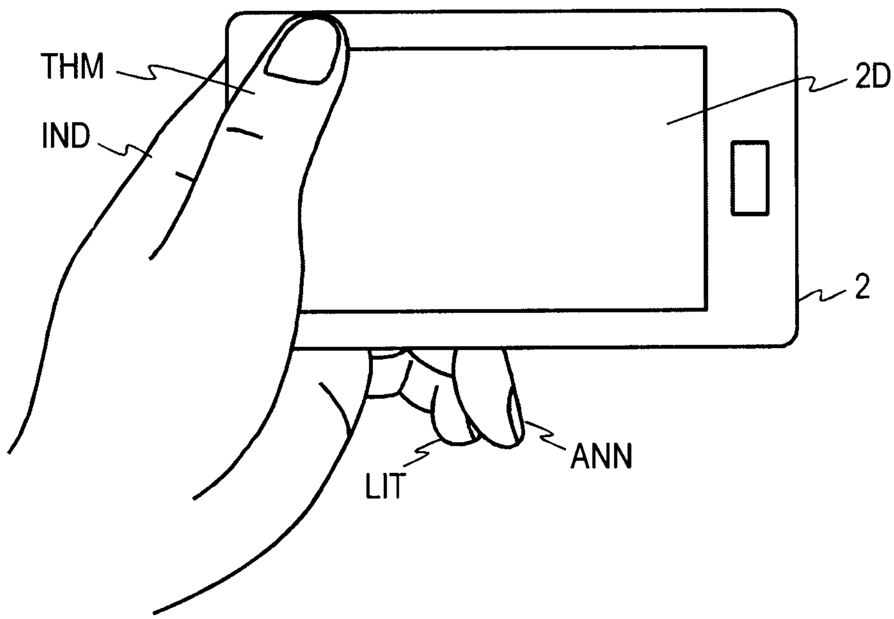


FIG. 2B

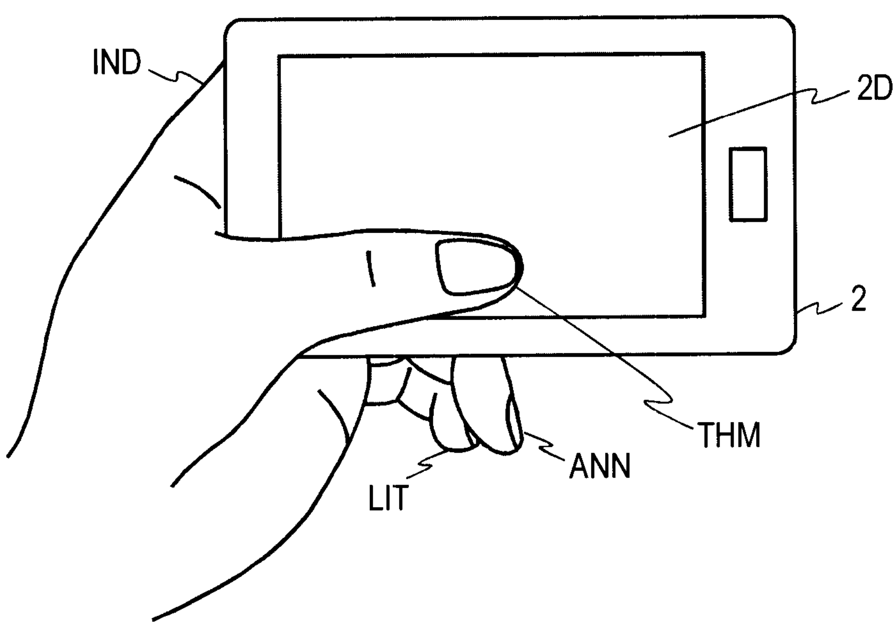


FIG. 3A

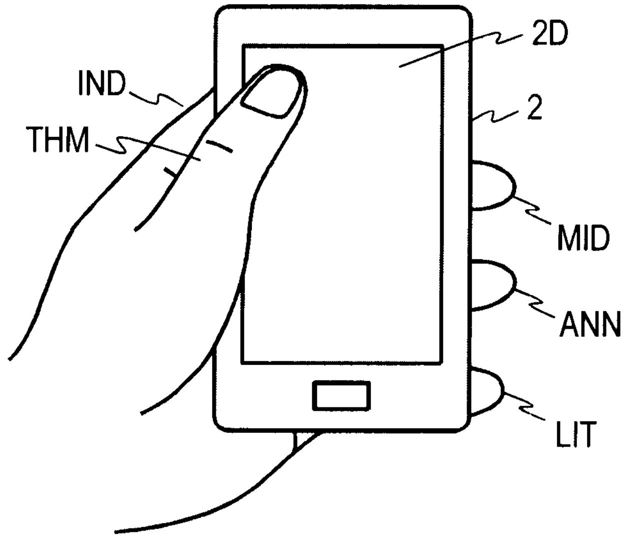


FIG. 3B

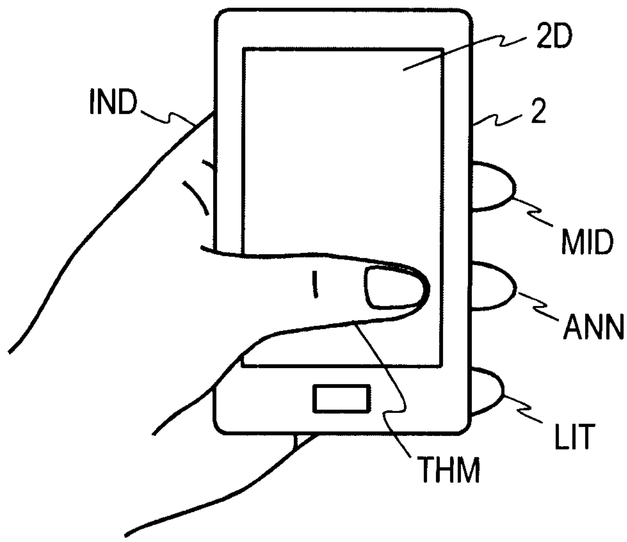


FIG. 3C

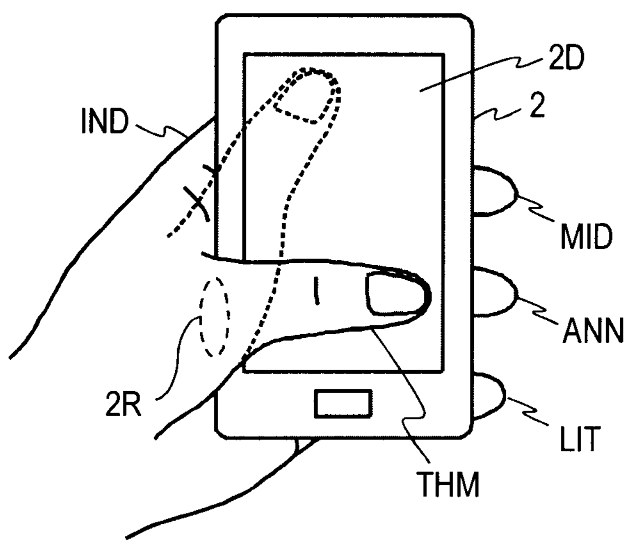
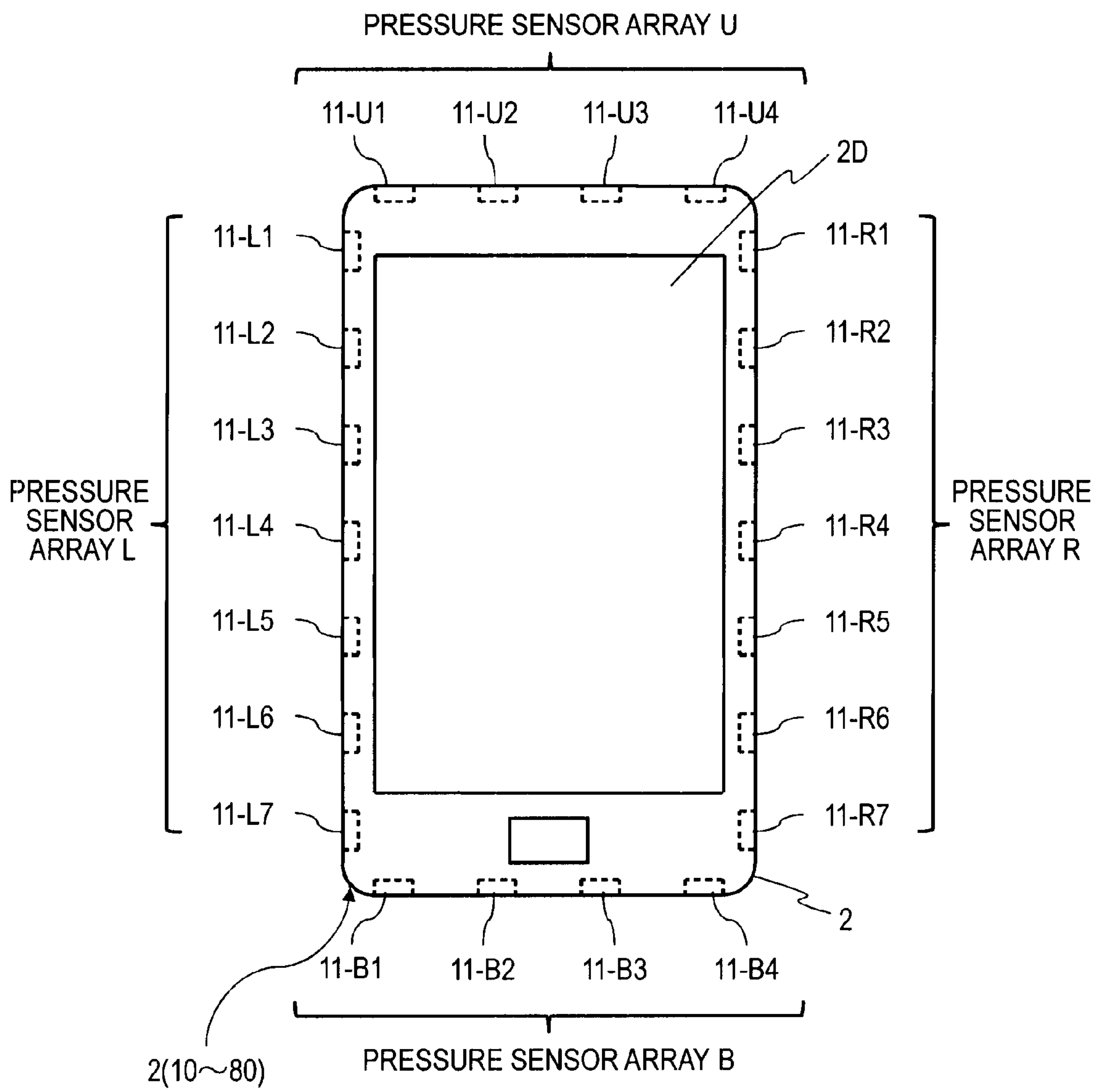


FIG. 4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11-U2
11-U3
11-U4
2D
11-L1
11-L2
11-L3
11-L4
11-L5
11-L6
11-L7
PRESSURE SENSOR ARRAY L
11-R1
11-R2
11-R3
11-R4
11-R5
11-R6
11-R7
PRESSURE SENSOR ARRAY R
2
11-B1
11-B2
11-B3
11-B4
2(10~80)
PRESSURE SENSOR ARRAY B

FIG. 5A

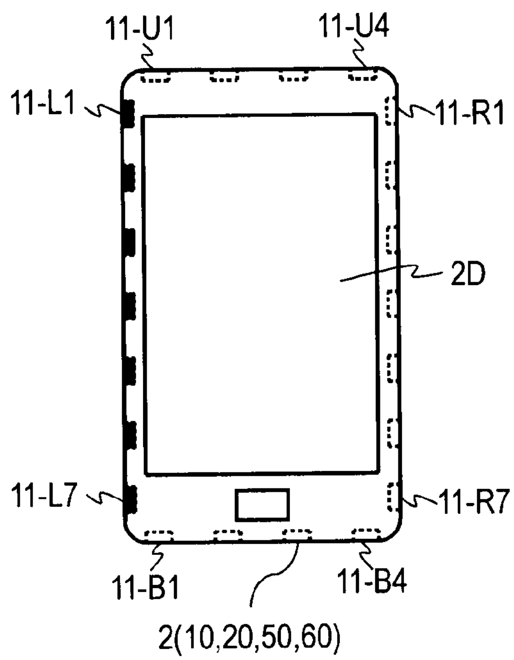


FIG. 5B

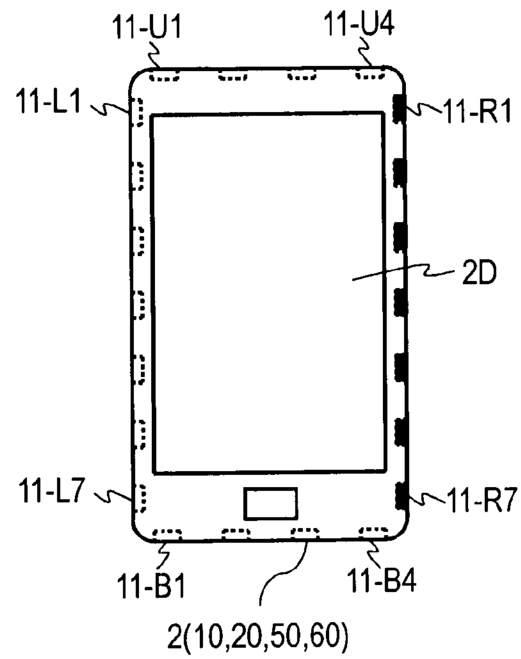


FIG. 5C

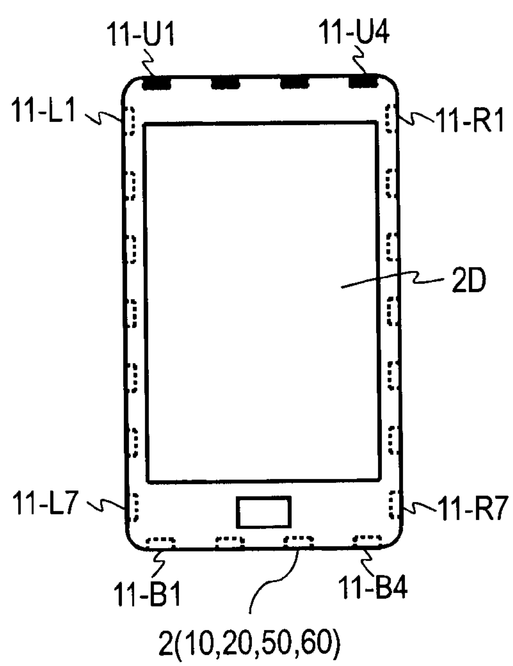
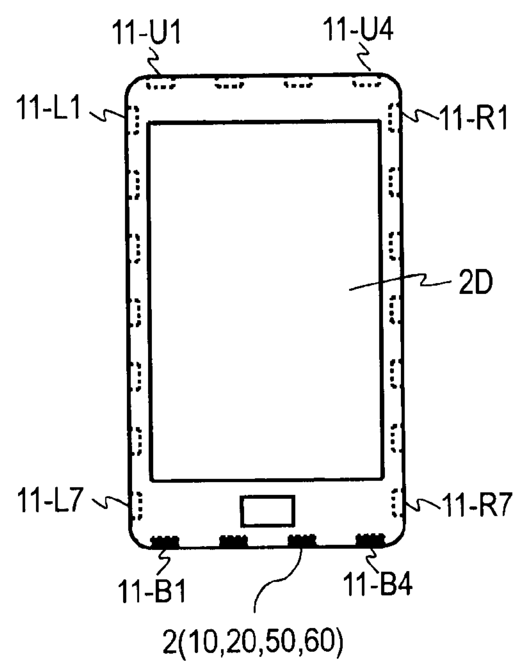


FIG. 5D



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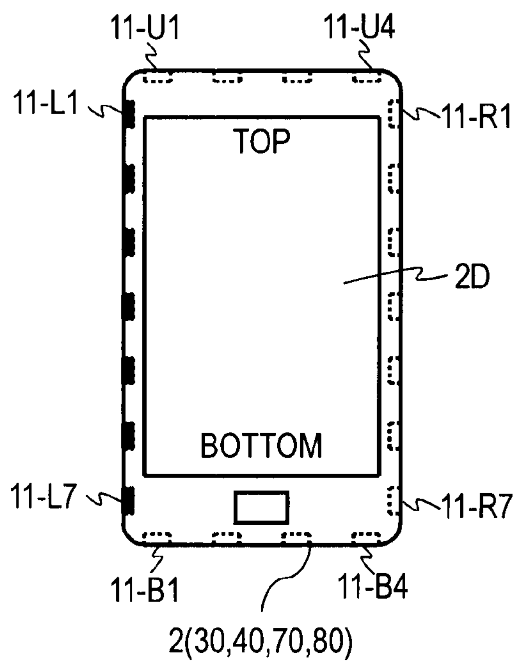


FIG. 6B

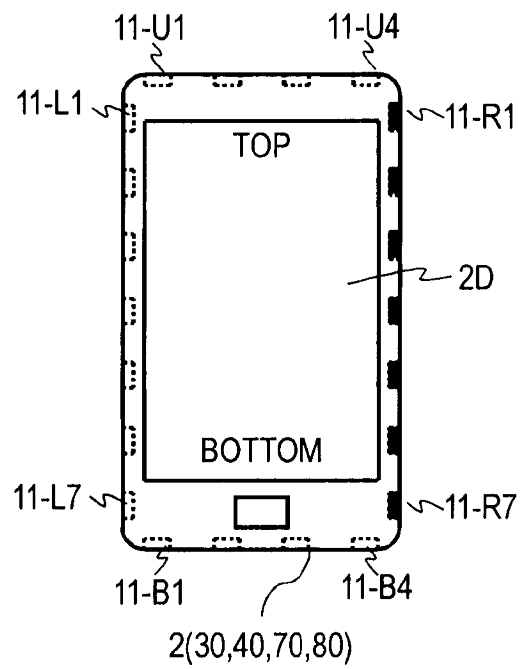


FIG. 6C

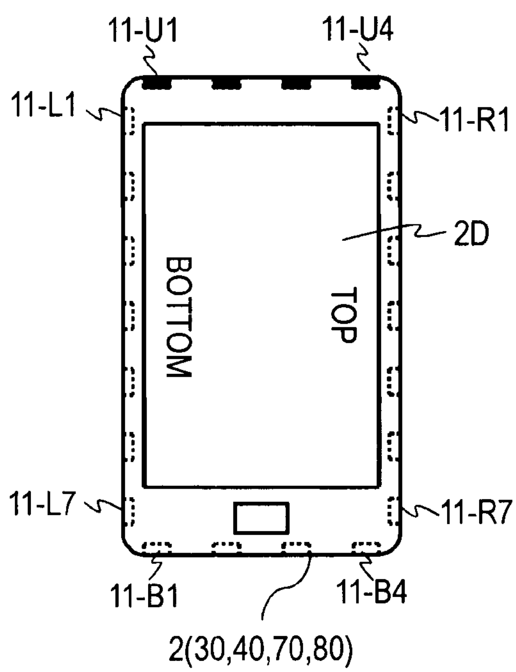
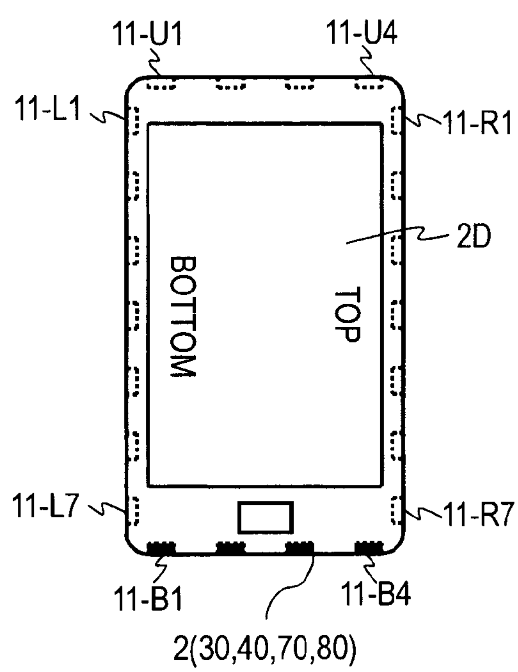


FIG. 6D



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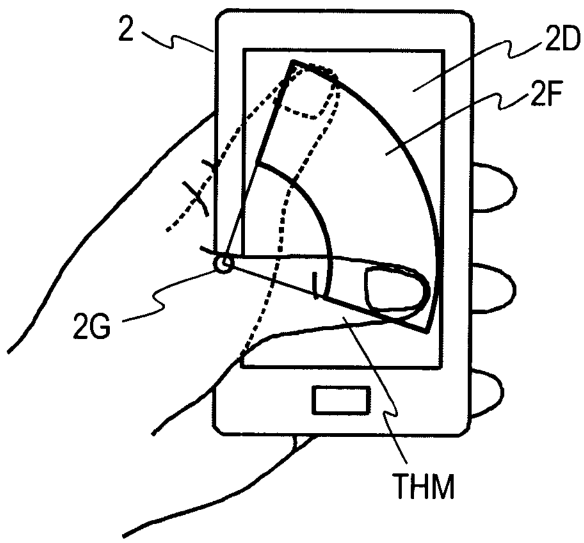


FIG. 7B

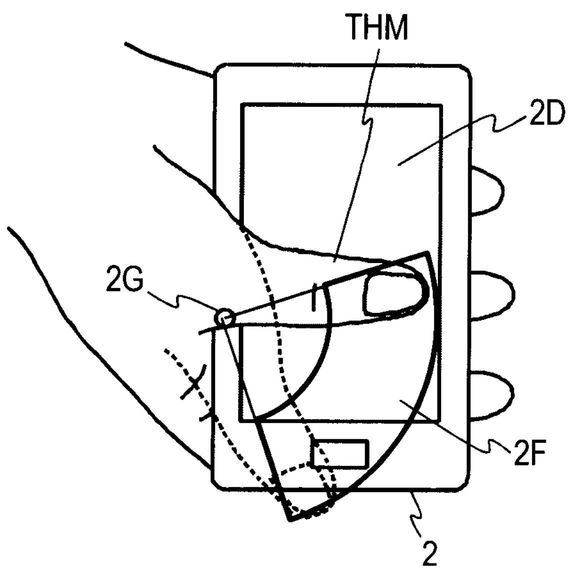


FIG. 7C

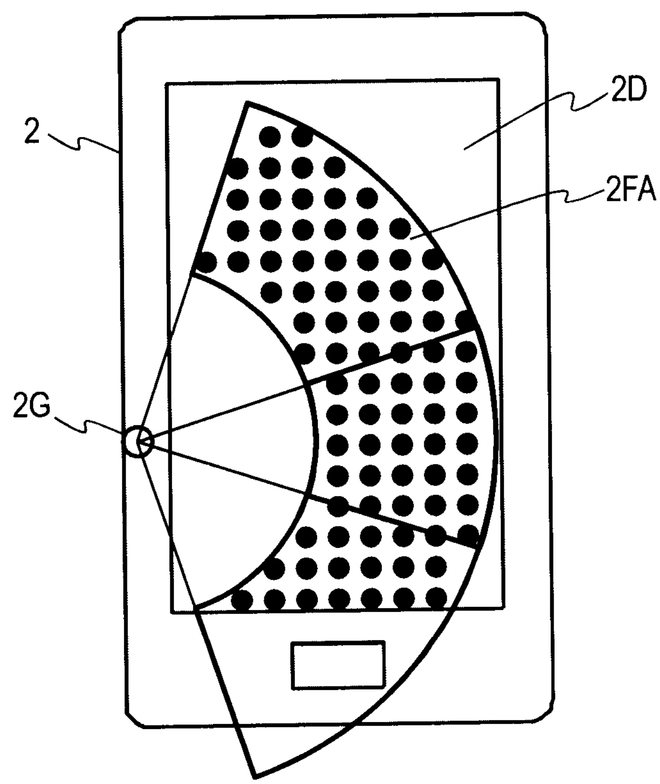
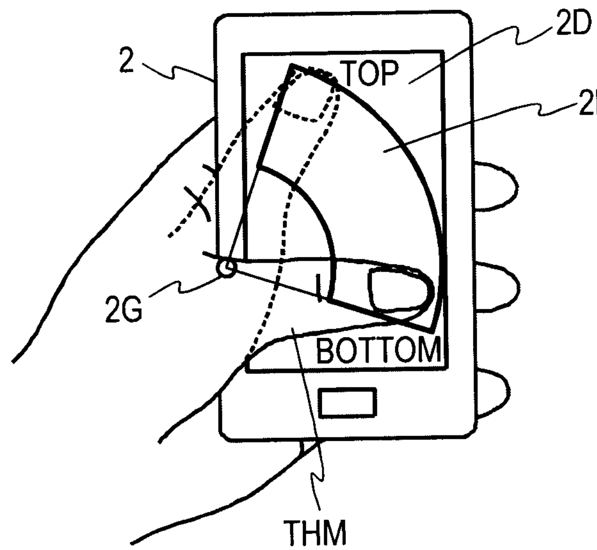


FIG. 8A



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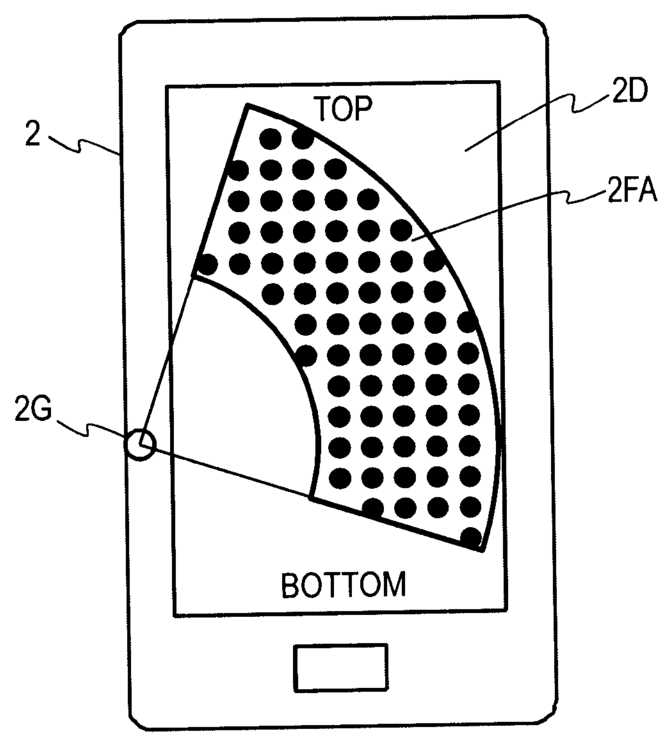

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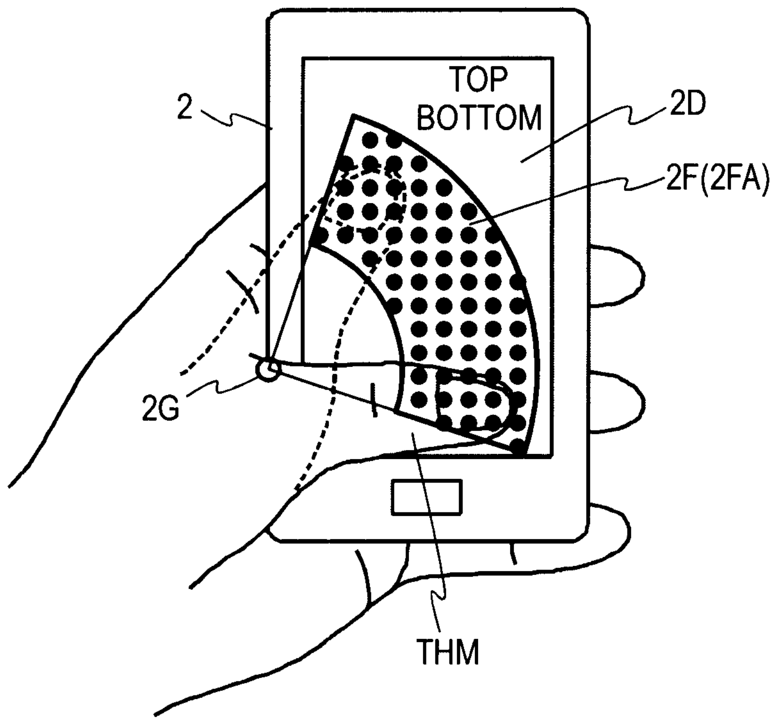


FIG. 9B

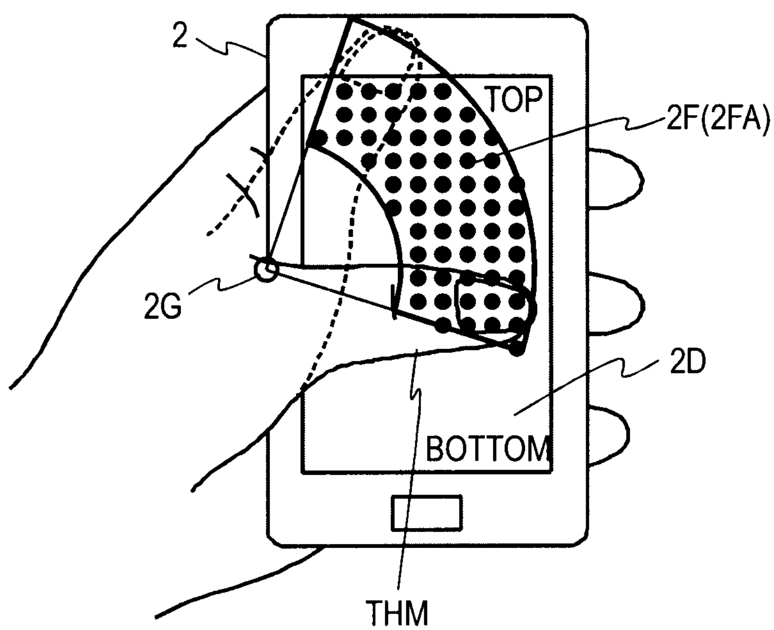
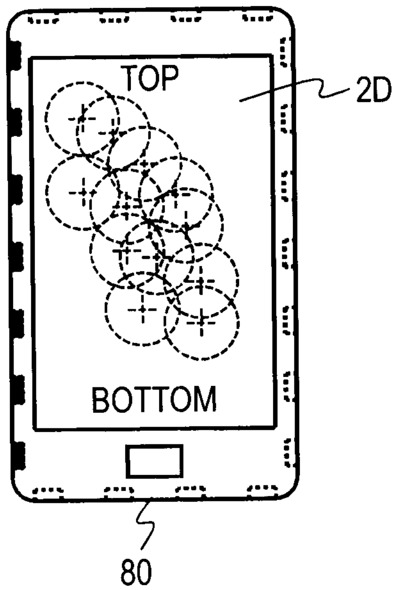


FIG. 10A



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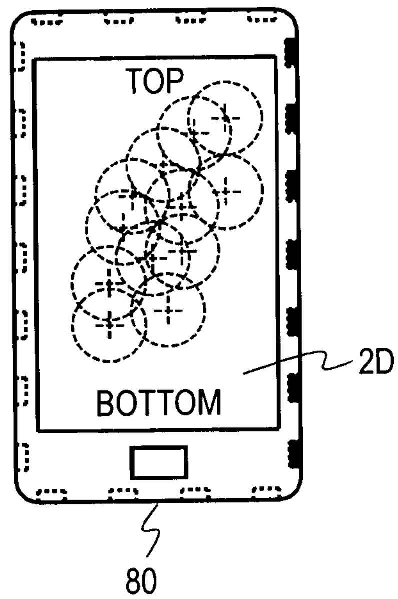


FIG. 10C

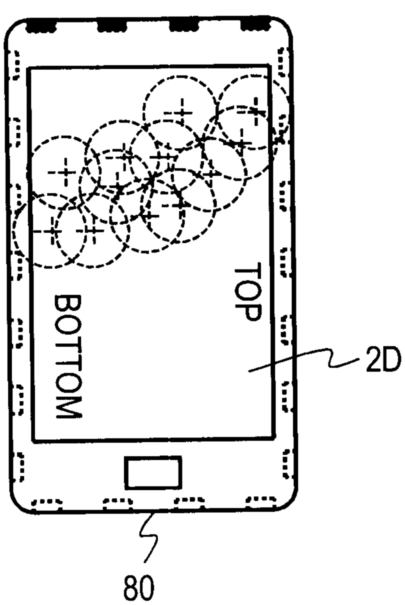


FIG. 10D

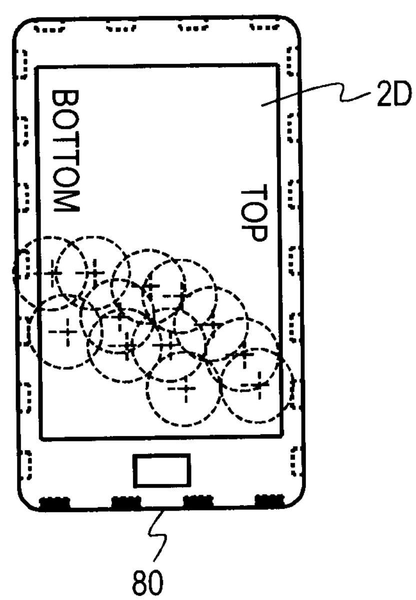
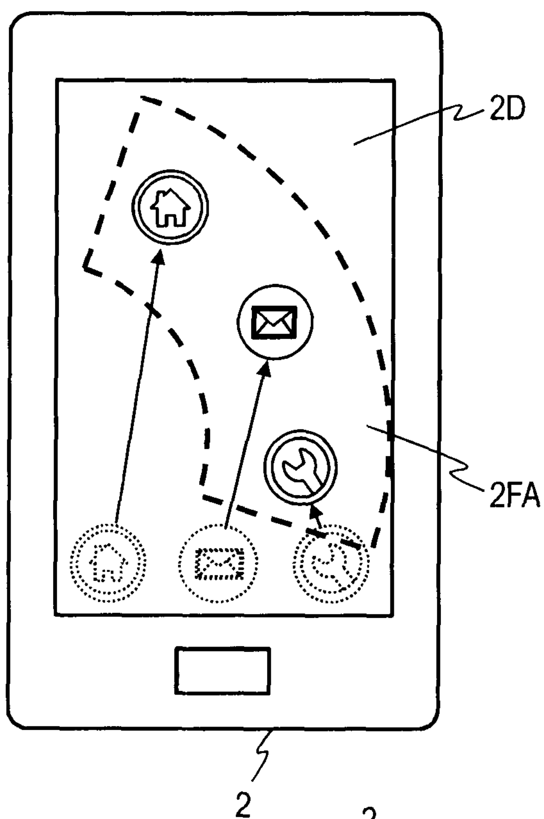


FIG. 11A



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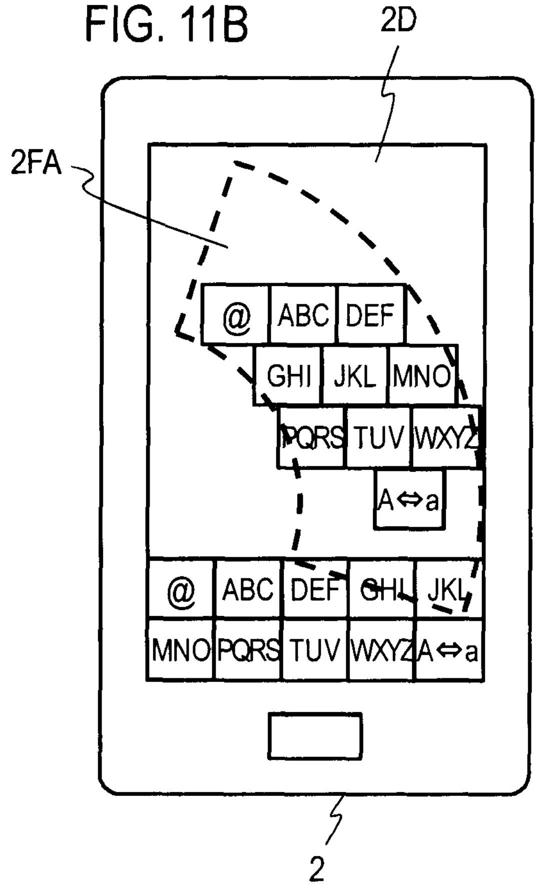

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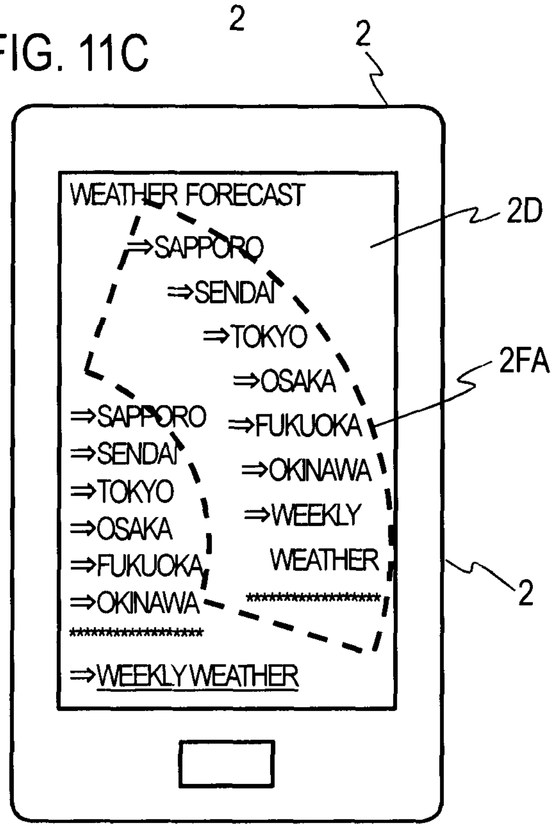
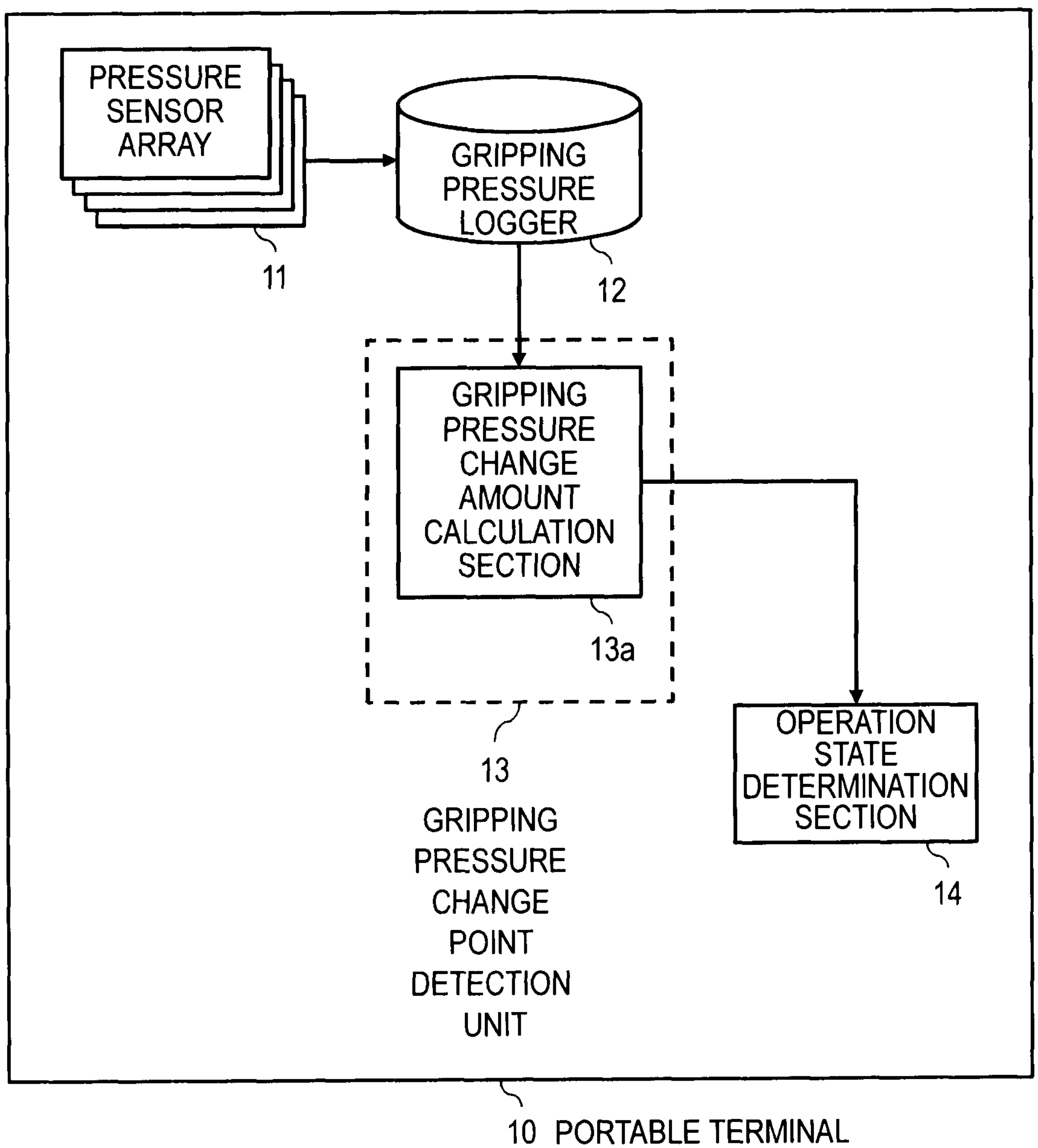


FIG. 12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11
GRIPPING PRESSURE LOGGER
12
GRIPPING PRESSURE CHANGE AMOUNT CALCULATION SECTION
13a
13
GRIPPING PRESSURE CHANGE POINT DETECTION UNIT
OPERATION STATE DETERMINATION SECTION
14
10 PORTABLE TERMINAL

FIG. 13

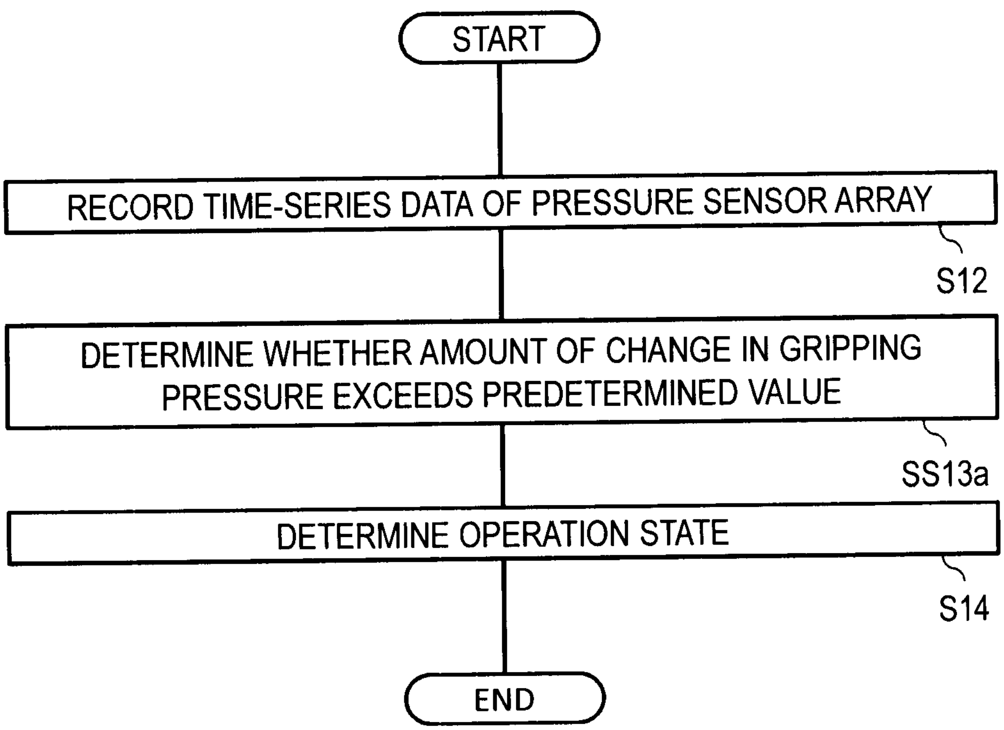
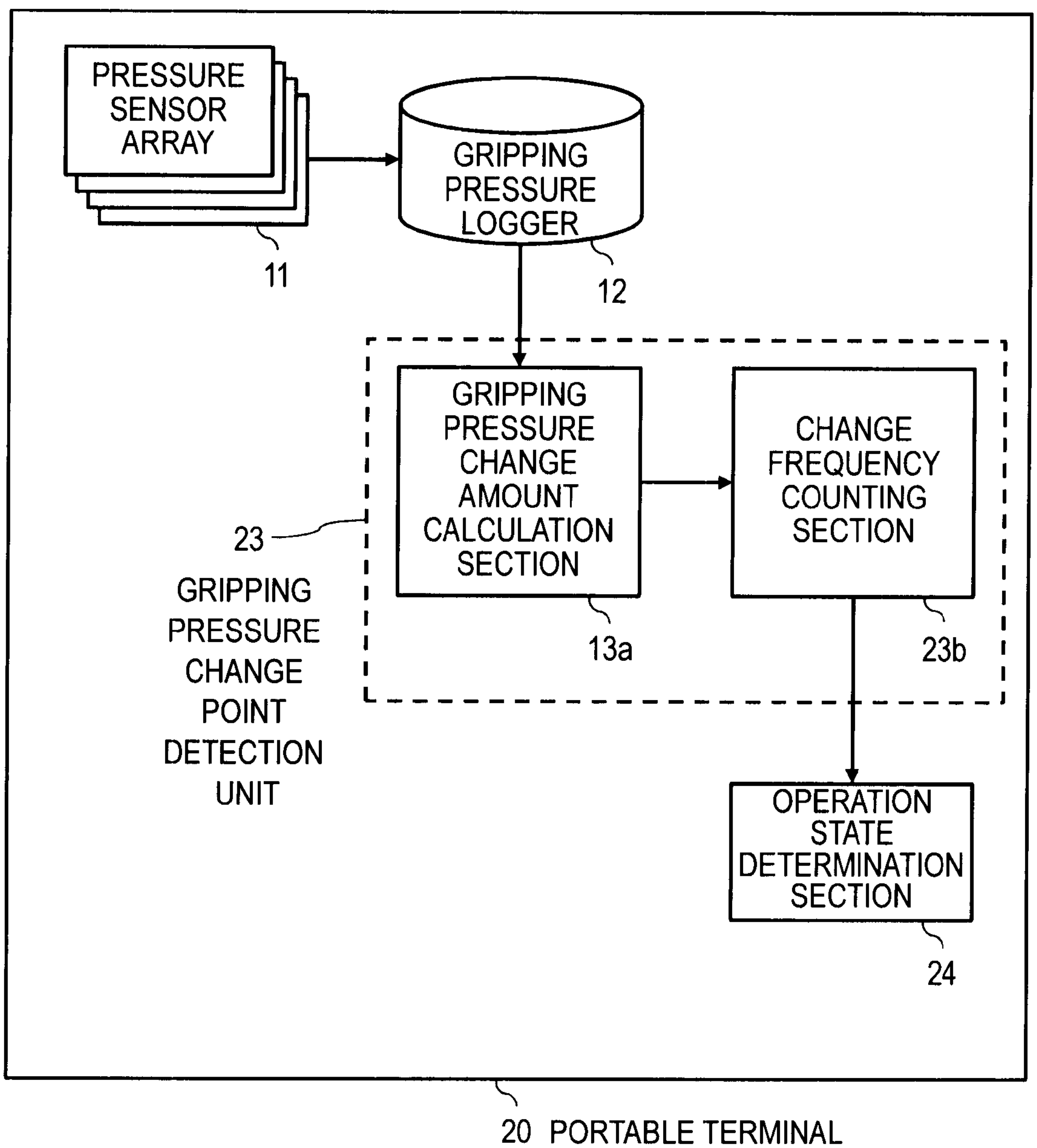

START
RECORD TIME-SERIES DATA OF PRESSURE SENSOR ARRAY
S12
DETERMINE WHETHER AMOUNT OF CHANGE IN GRIPPING PRESSURE EXCEEDS PREDETERMINED VALUE
SS13a
DETERMINE OPERATION STATE
S14
END

FIG. 14


PRESSURE SENSOR ARRAY
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13a
CHANGE FREQUENCY COUNTING SECTION
23b
23
GRIPPING PRESSURE CHANGE POINT DETECTION UNIT
OPERATION STATE DETERMINATION SECTION
24
20 PORTABLE TERMINAL

FIG. 15

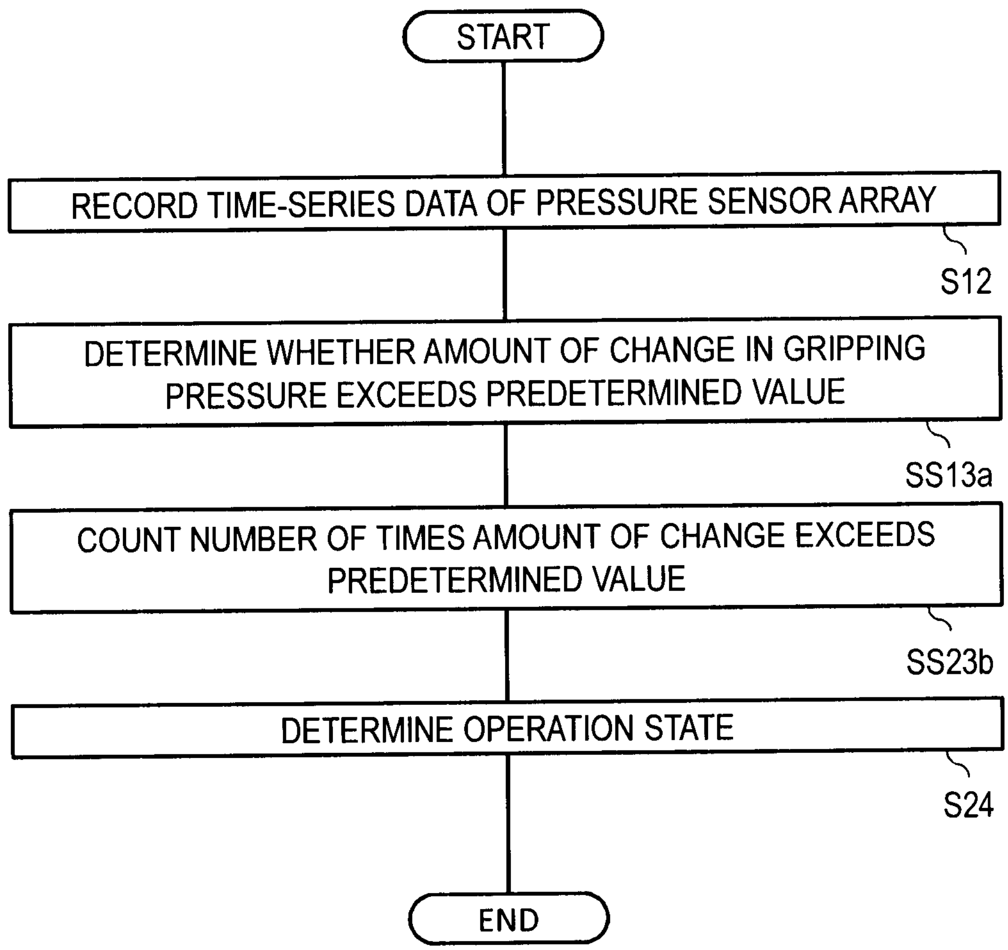

START
RECORD TIME-SERIES DATA OF PRESSURE SENSOR ARRAY
S12
DETERMINE WHETHER AMOUNT OF CHANGE IN GRIPPING PRESSURE EXCEEDS PREDETERMINED VALUE
SS13a
COUNT NUMBER OF TIMES AMOUNT OF CHANGE EXCEEDS PREDETERMINED VALUE
SS23b
DETERMINE OPERATION STATE
S24
END

FIG. 16

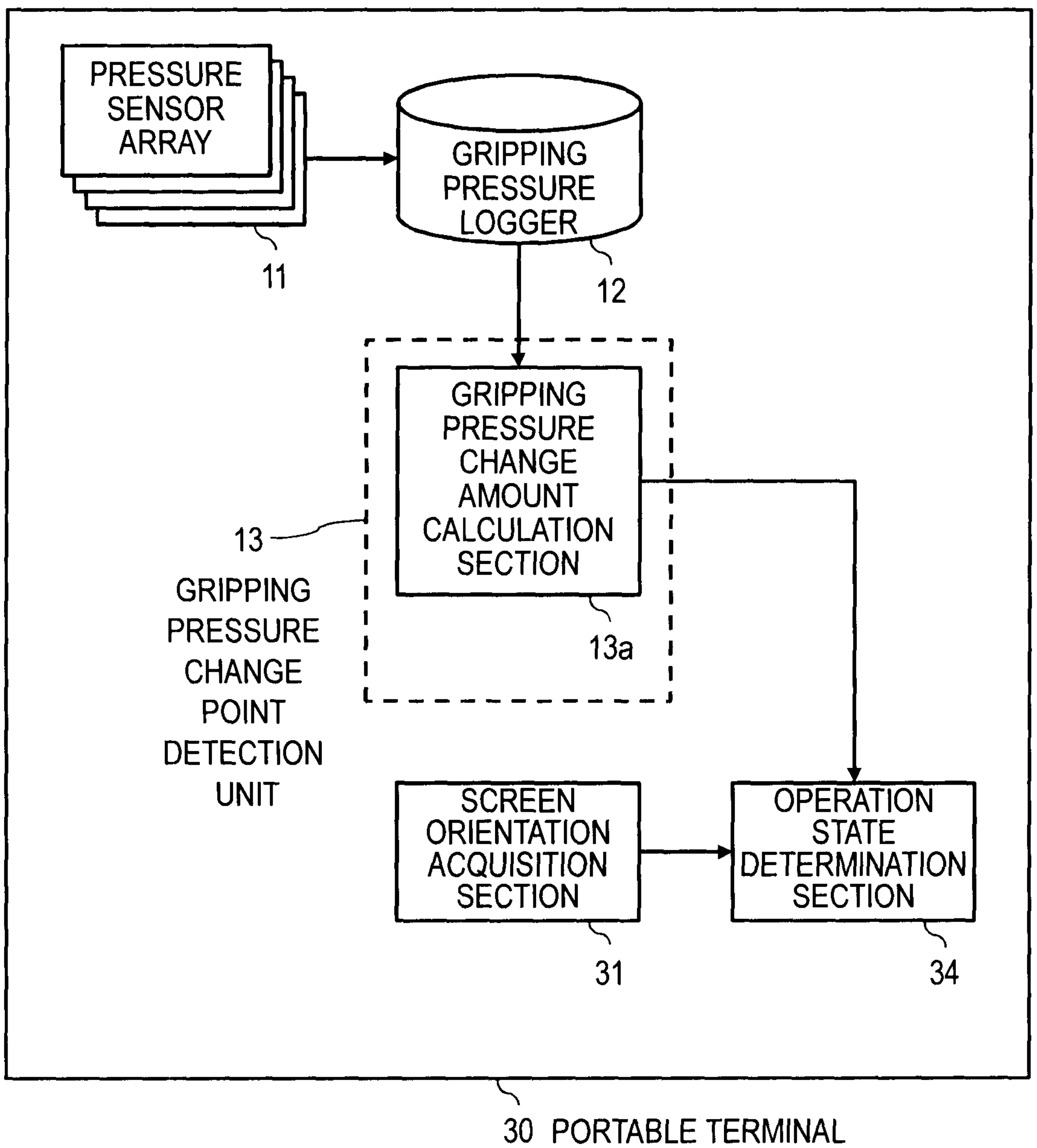

PRESSURE SENSOR ARRAY
11
GRIPPING PRESSURE LOGGER
12
GRIPPING PRESSURE CHANGE AMOUNT CALCULATION SECTION
13a
13
GRIPPING PRESSURE CHANGE POINT DETECTION UNIT
SCREEN ORIENTATION ACQUISITION SECTION
31
OPERATION STATE DETERMINATION SECTION
34
30 PORTABLE TERMINAL

FIG. 17

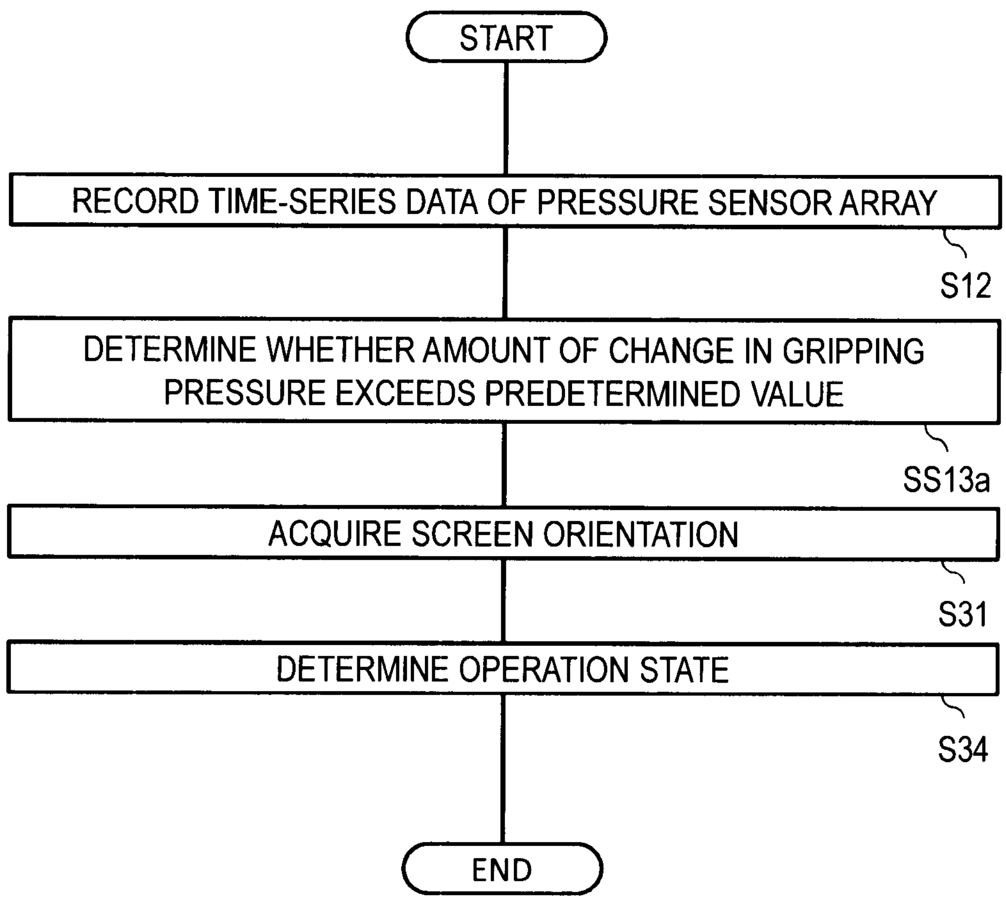
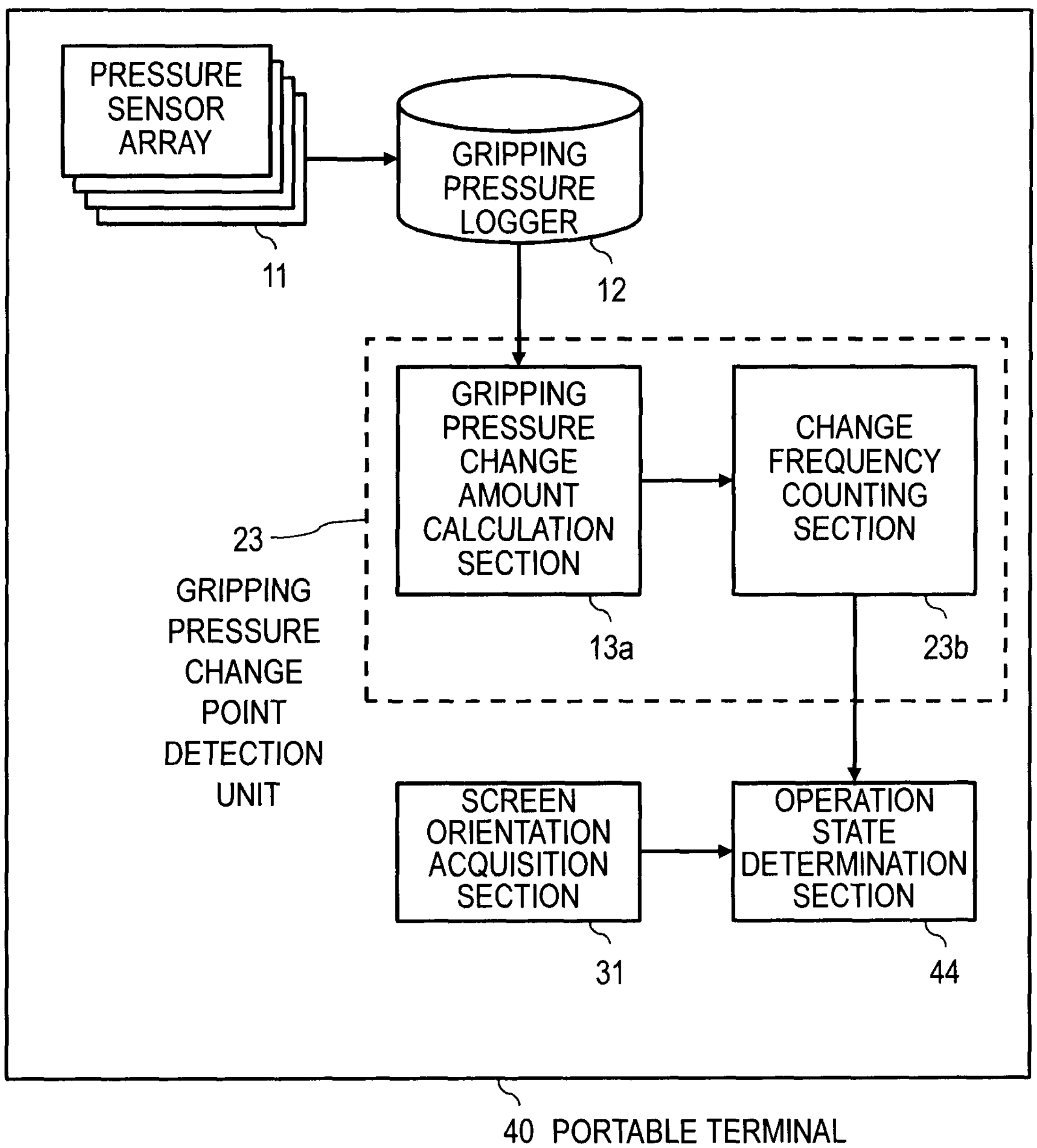

START
RECORD TIME-SERIES DATA OF PRESSURE SENSOR ARRAY
S12
DETERMINE WHETHER AMOUNT OF CHANGE IN GRIPPING PRESSURE EXCEEDS PREDETERMINED VALUE
SS13a
ACQUIRE SCREEN ORIENTATION
S31
DETERMINE OPERATION STATE
S34
END

FIG. 18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GRIPPING PRESSURE LOGGER
12
23
GRIPPING PRESSURE CHANGE POINT DETECTION UNIT
GRIPPING PRESSURE CHANGE AMOUNT CALCULATION SECTION
13a
CHANGE FREQUENCY COUNTING SECTION
23b
SCREEN ORIENTATION ACQUISITION SECTION
31
OPERATION STATE DETERMINATION SECTION
44
40 PORTABLE TERMINAL

FIG. 19

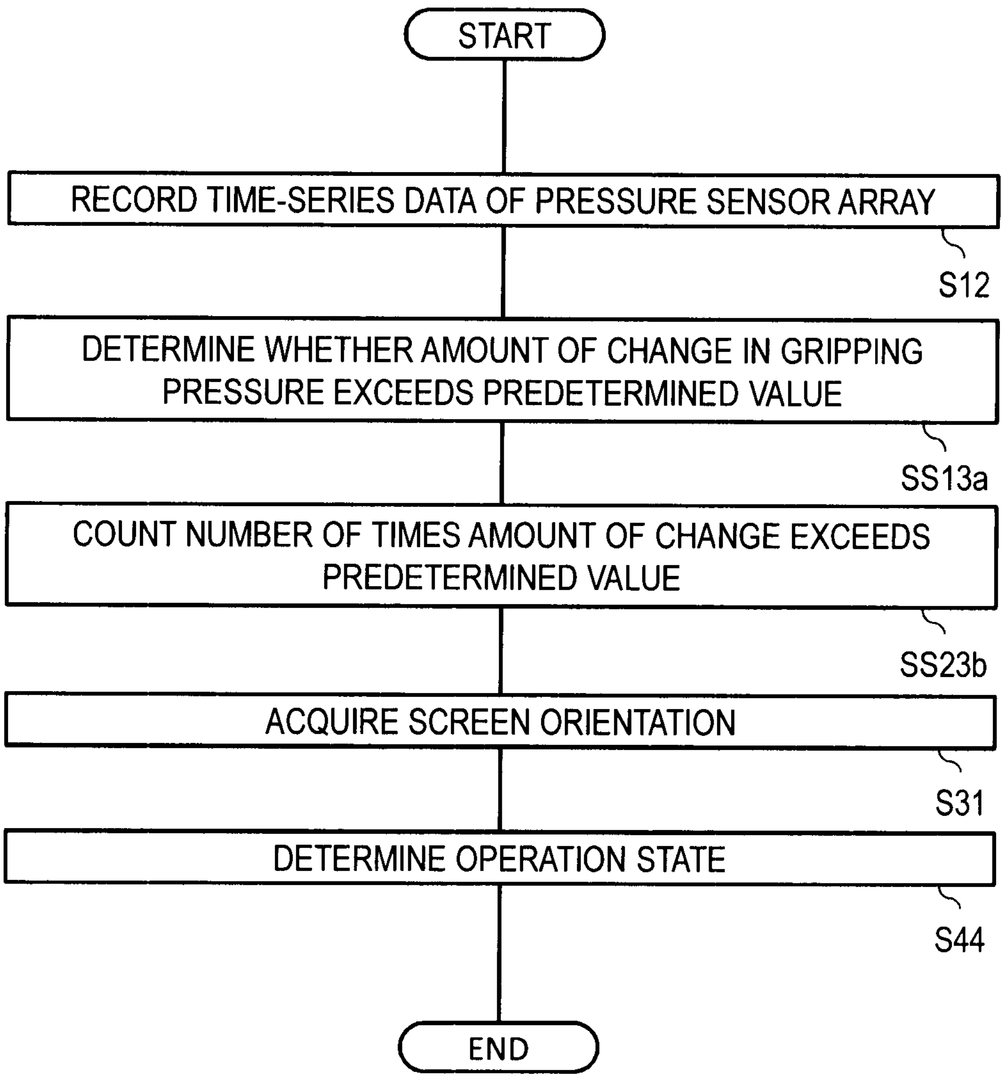
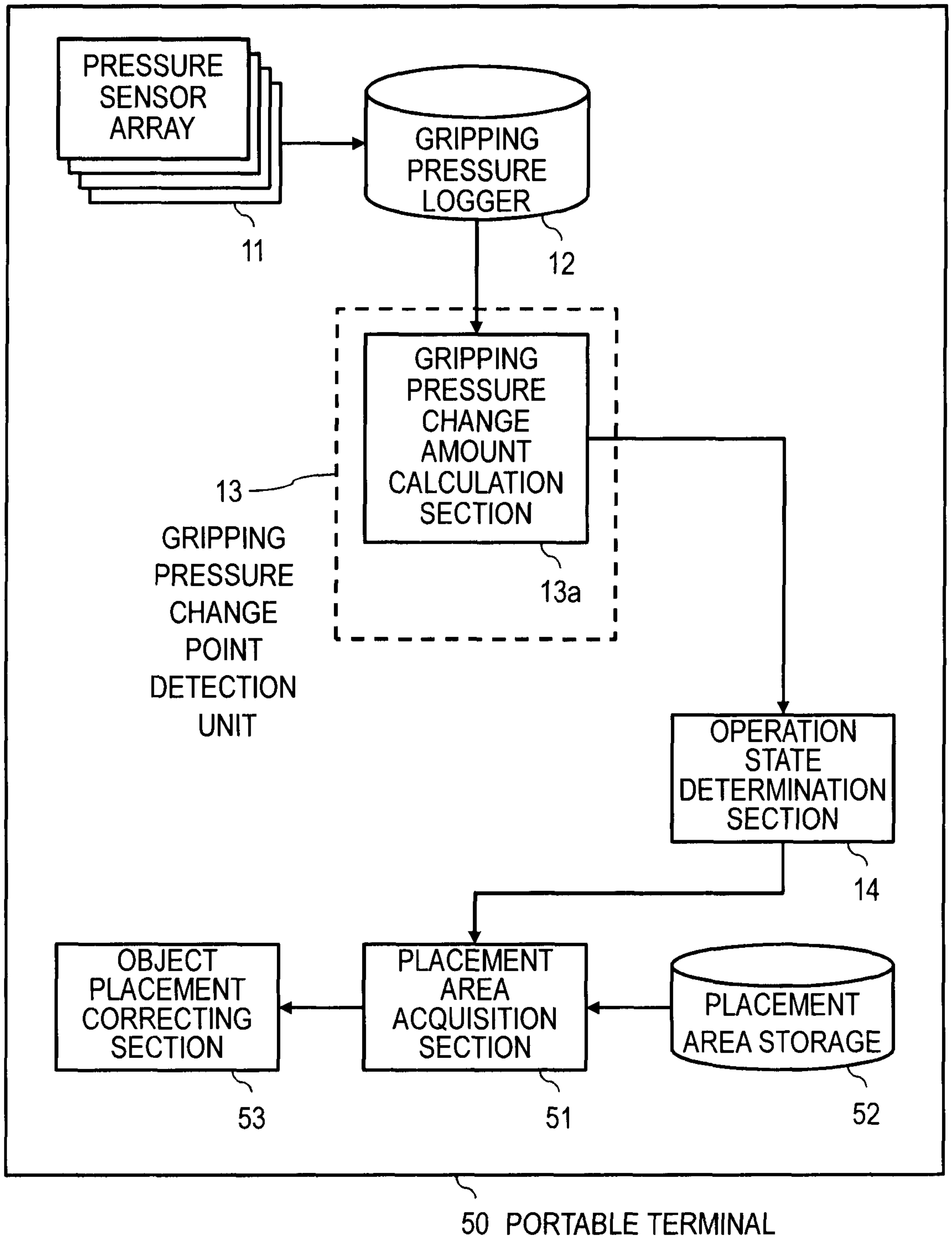

START
RECORD TIME-SERIES DATA OF PRESSURE SENSOR ARRAY
S12
DETERMINE WHETHER AMOUNT OF CHANGE IN GRIPPING PRESSURE EXCEEDS PREDETERMINED VALUE
SS13a
COUNT NUMBER OF TIMES AMOUNT OF CHANGE EXCEEDS PREDETERMINED VALUE
SS23b
ACQUIRE SCREEN ORIENTATION
S31
DETERMINE OPERATION STATE
S44
END

FIG. 20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GRIPPING PRESSURE CHANGE AMOUNT CALCULATION SECTION
13a
13
GRIPPING PRESSURE CHANGE POINT DETECTION UNIT
OPERATION STATE DETERMINATION SECTION
14
OBJECT PLACEMENT CORRECTING SECTION
53
PLACEMENT AREA ACQUISITION SECTION
51
PLACEMENT AREA STORAGE
52
50 PORTABLE TERMINAL

FIG. 21

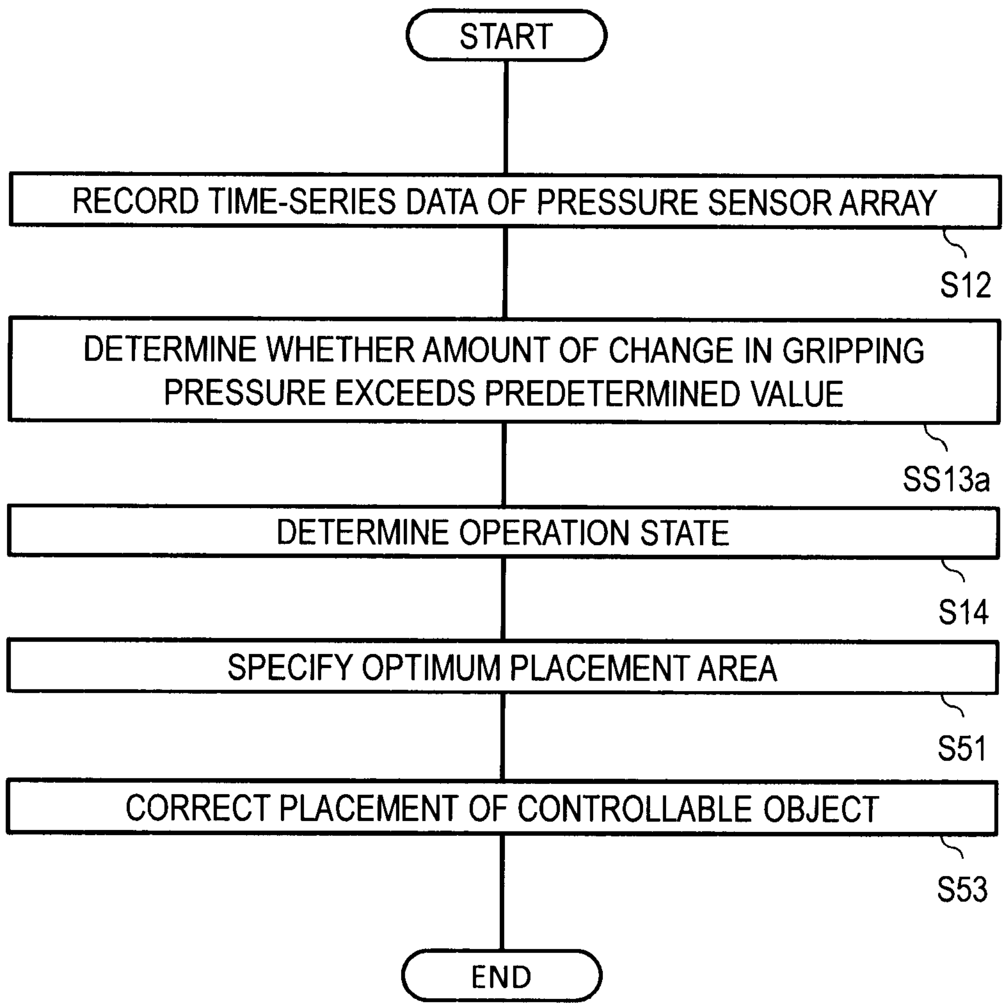
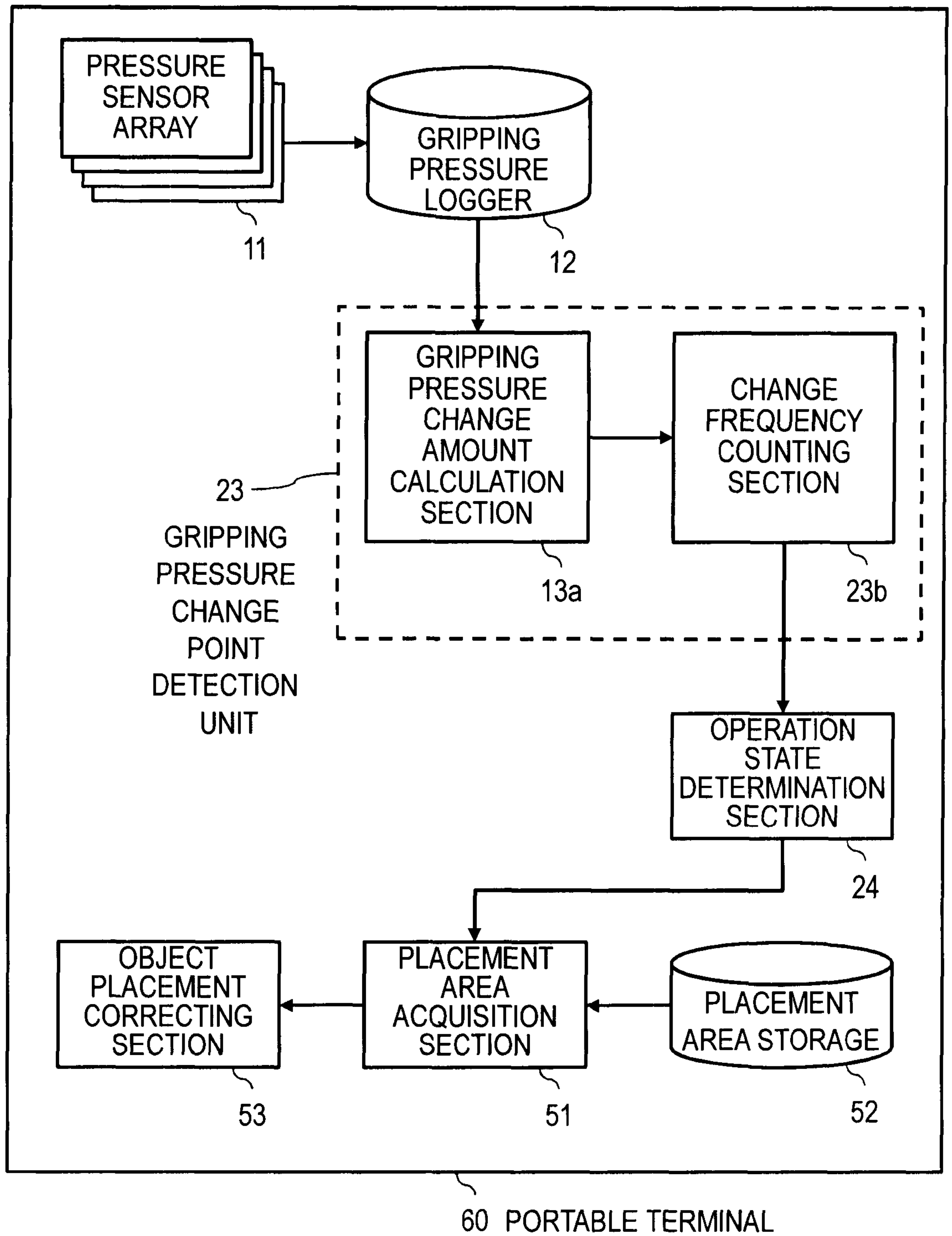

START
RECORD TIME-SERIES DATA OF PRESSURE SENSOR ARRAY
S12
DETERMINE WHETHER AMOUNT OF CHANGE IN GRIPPING PRESSURE EXCEEDS PREDETERMINED VALUE
SS13a
DETERMINE OPERATION STATE
S14
SPECIFY OPTIMUM PLACEMENT AREA
S51
CORRECT PLACEMENT OF CONTROLLABLE OBJECT
S53
END

FIG. 22


PRESSURE SENSOR ARRAY
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13a
CHANGE FREQUENCY COUNTING SECTION
23b
23
GRIPPING PRESSURE CHANGE POINT DETECTION UNIT
OPERATION STATE DETERMINATION SECTION
24
OBJECT PLACEMENT CORRECTING SECTION
53
PLACEMENT AREA ACQUISITION SECTION
51
PLACEMENT AREA STORAGE
52
60 PORTABLE TERMINAL

FIG. 23

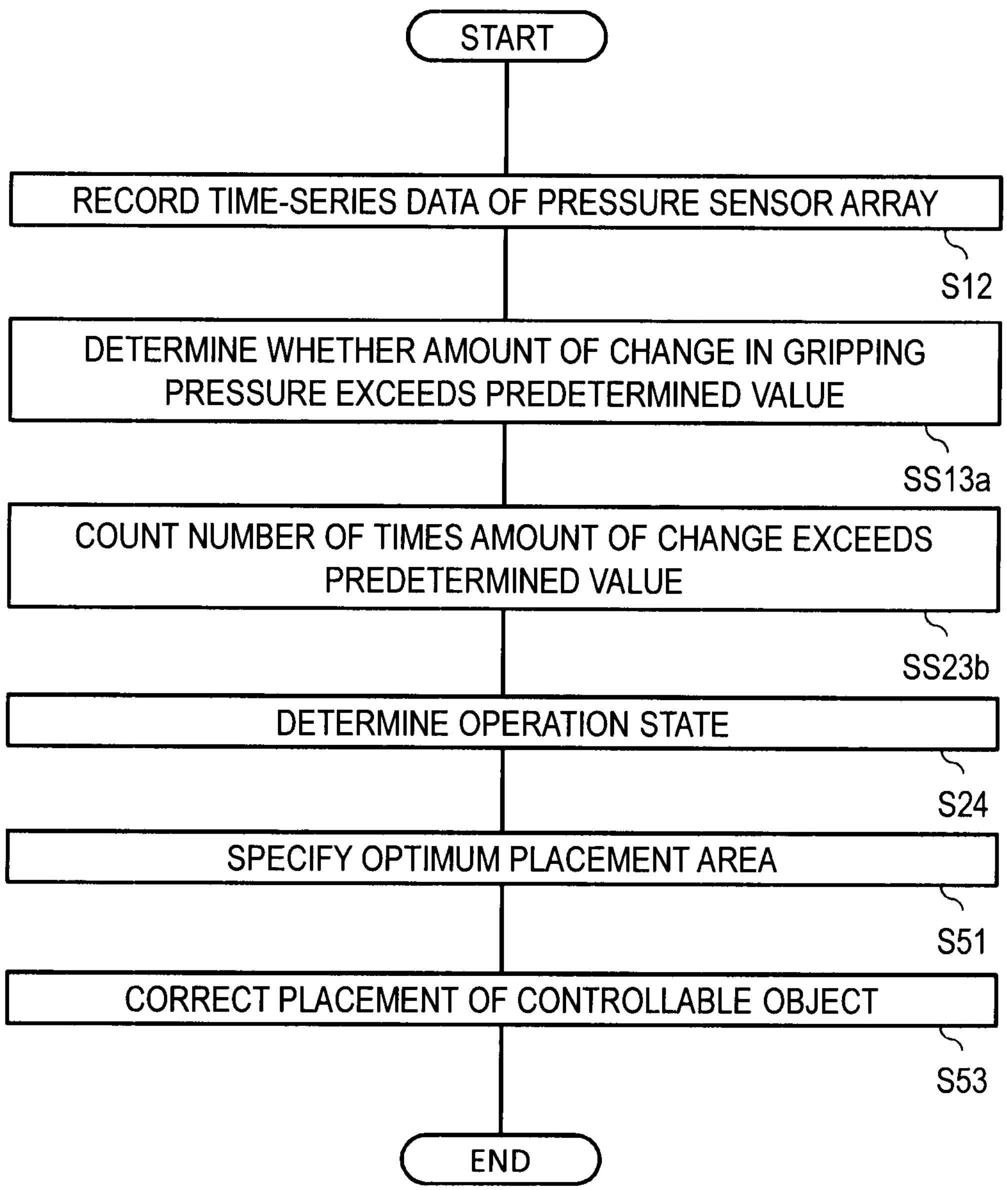
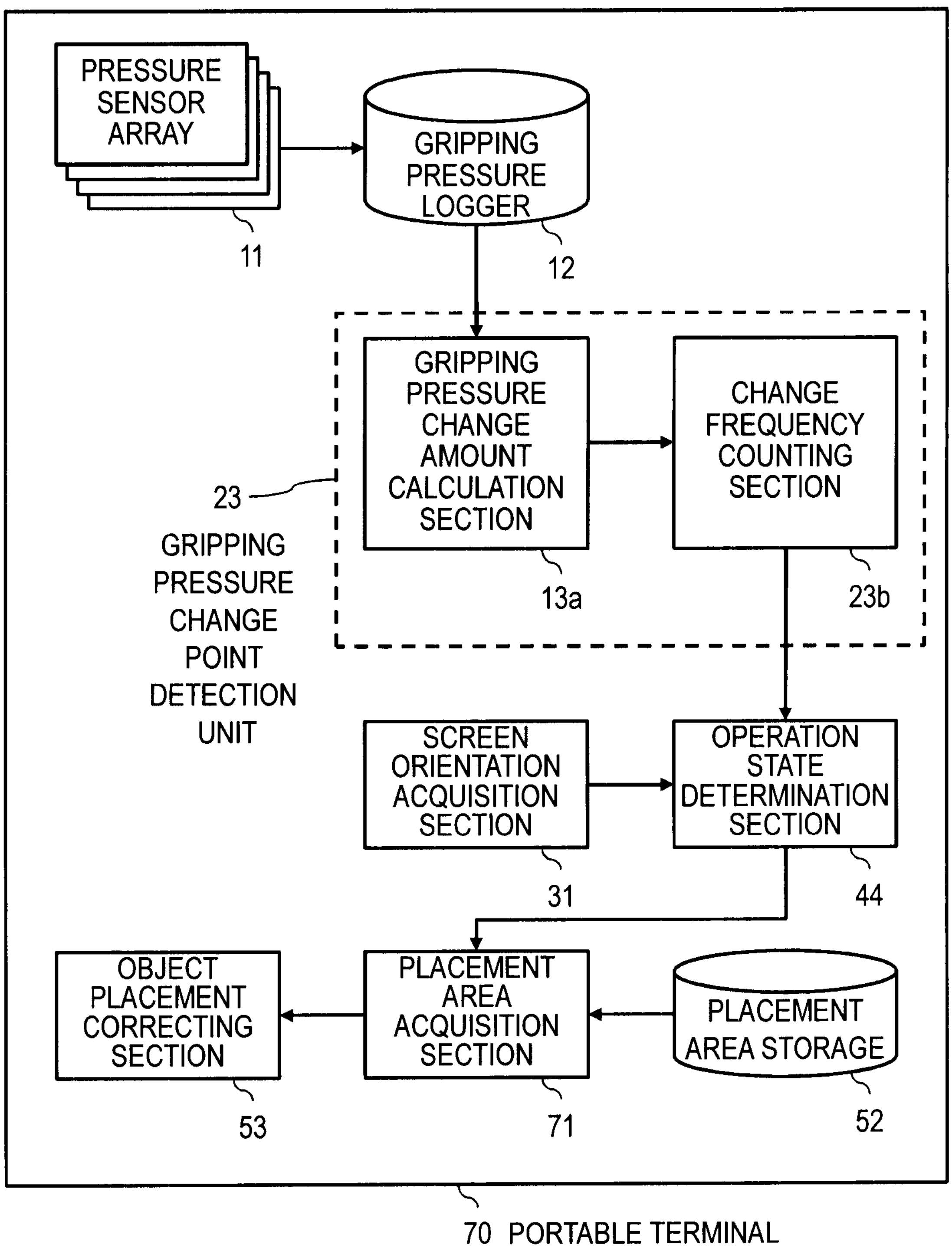

START
RECORD TIME-SERIES DATA OF PRESSURE SENSOR ARRAY
S12
DETERMINE WHETHER AMOUNT OF CHANGE IN GRIPPING PRESSURE EXCEEDS PREDETERMINED VALUE
SS13a
COUNT NUMBER OF TIMES AMOUNT OF CHANGE EXCEEDS PREDETERMINED VALUE
SS23b
DETERMINE OPERATION STATE
S24
SPECIFY OPTIMUM PLACEMENT AREA
S51
CORRECT PLACEMENT OF CONTROLLABLE OBJECT
S53
END

FIG. 24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13a
CHANGE FREQUENCY COUNTING SECTION
23b
23
GRIPPING PRESSURE CHANGE POINT DETECTION UNIT
SCREEN ORIENTATION ACQUISITION SECTION
31
OPERATION STATE DETERMINATION SECTION
44
OBJECT PLACEMENT CORRECTING SECTION
53
PLACEMENT AREA ACQUISITION SECTION
71
PLACEMENT AREA STORAGE
52
70 PORTABLE TERMINAL

FIG. 25

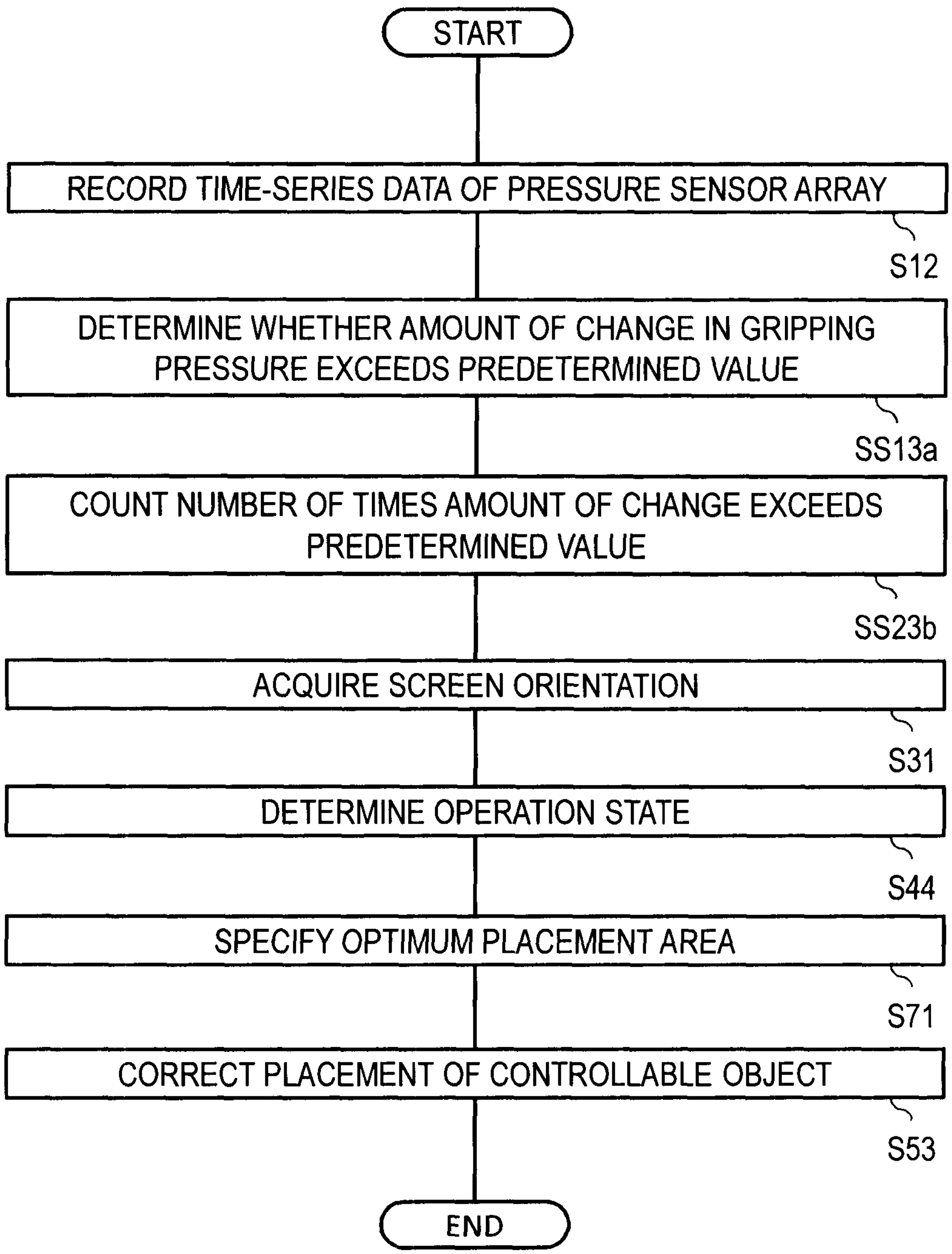
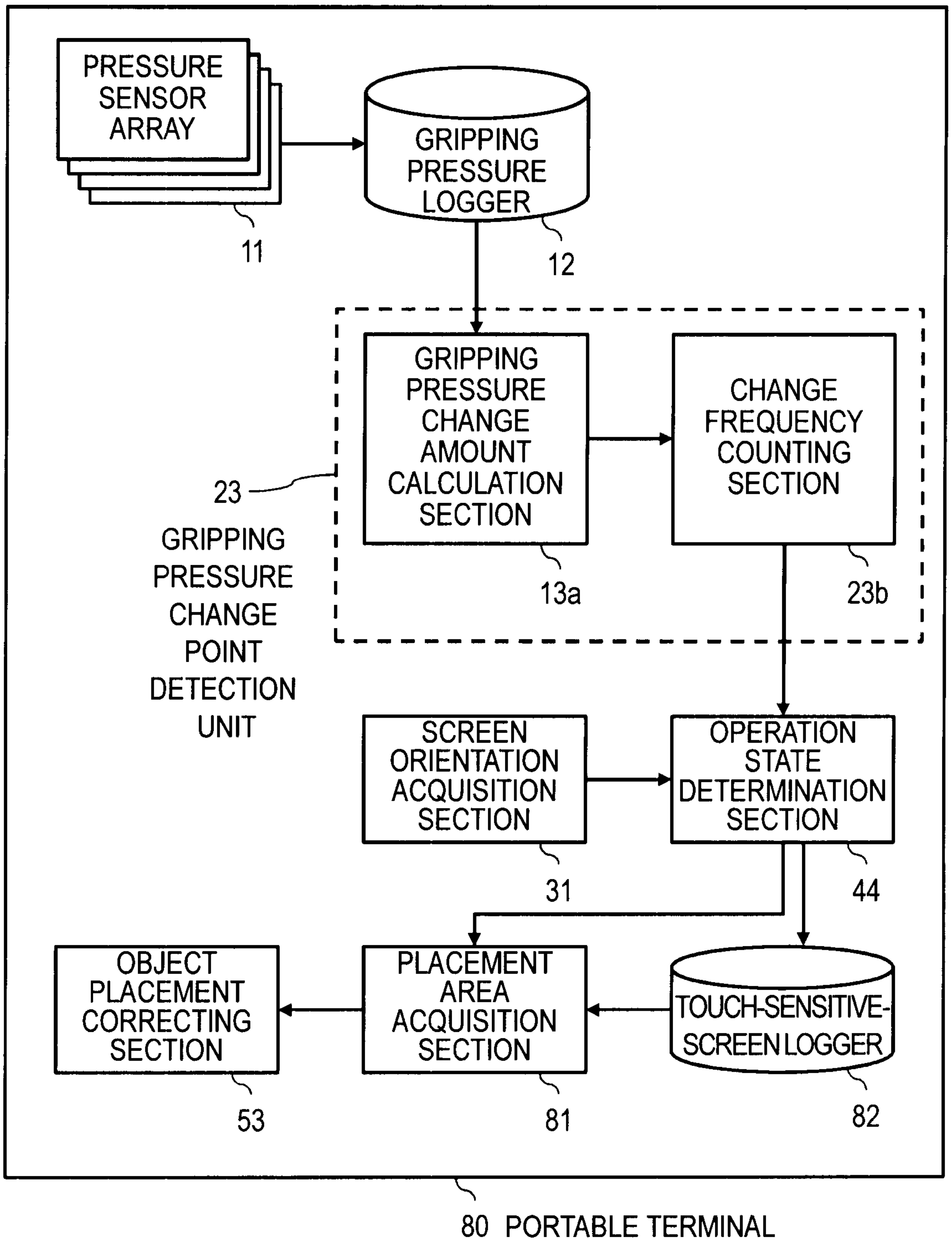

START
RECORD TIME-SERIES DATA OF PRESSURE SENSOR ARRAY
S12
DETERMINE WHETHER AMOUNT OF CHANGE IN GRIPPING PRESSURE EXCEEDS PREDETERMINED VALUE
SS13a
COUNT NUMBER OF TIMES AMOUNT OF CHANGE EXCEEDS PREDETERMINED VALUE
SS23b
ACQUIRE SCREEN ORIENTATION
S31
DETERMINE OPERATION STATE
S44
SPECIFY OPTIMUM PLACEMENT AREA
S71
CORRECT PLACEMENT OF CONTROLLABLE OBJECT
S53
END

FIG. 26


PRESSURE SENSOR ARRAY
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GRIPPING PRESSURE LOGGER
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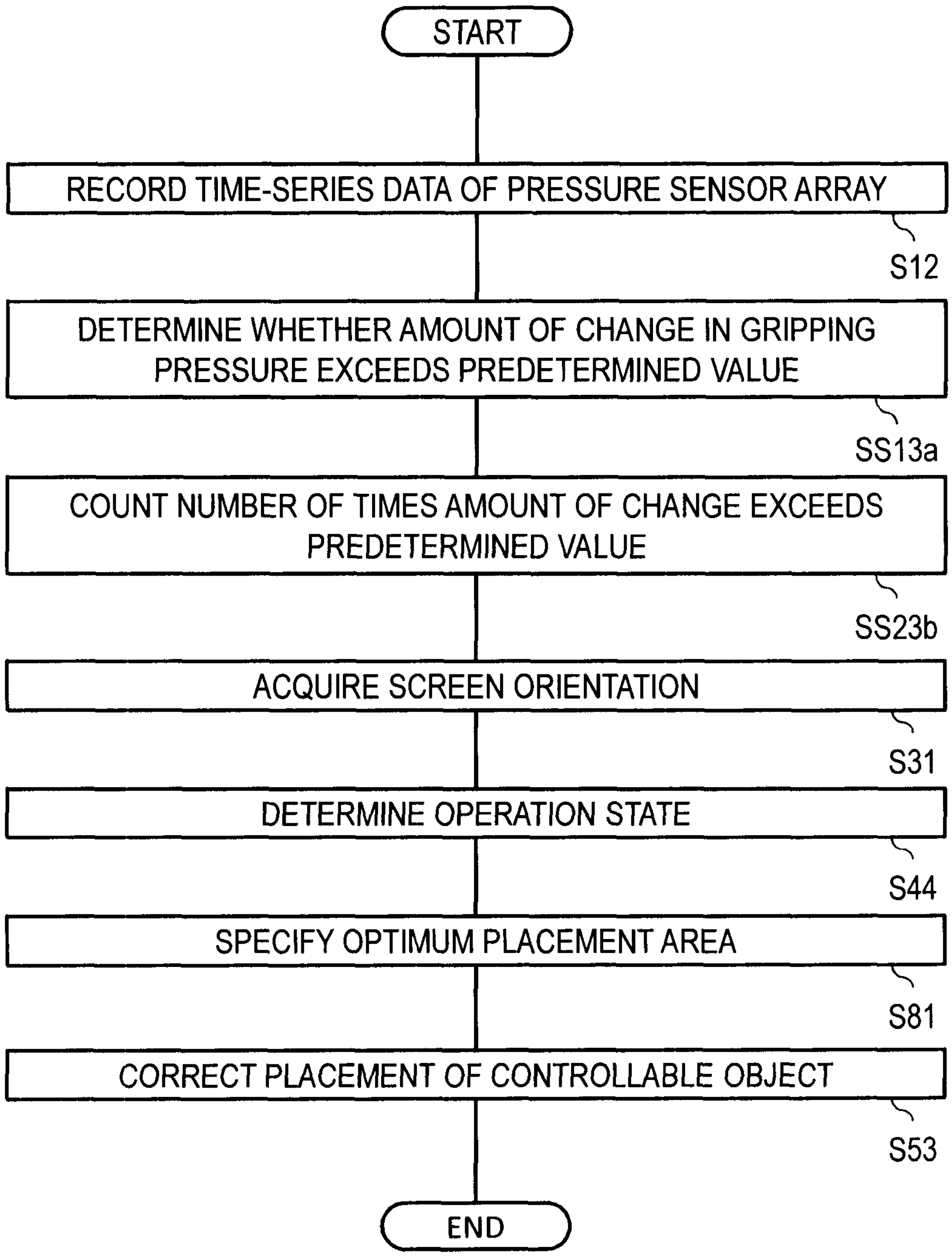
GRIPPING PRESSURE CHANGE AMOUNT CALCULATION SECTION
13a
CHANGE FREQUENCY COUNTING SECTION
23b
23
GRIPPING PRESSURE CHANGE POINT DETECTION UNIT
SCREEN ORIENTATION ACQUISITION SECTION
31
OPERATION STATE DETERMINATION SECTION
44
OBJECT PLACEMENT CORRECTING SECTION
53
PLACEMENT AREA ACQUISITION SECTION
81
TOUCH-SENSITIVE-SCREEN LOGGER
82
80 PORTABLE TERMINAL

FIG. 27


START
RECORD TIME-SERIES DATA OF PRESSURE SENSOR ARRAY
S12
DETERMINE WHETHER AMOUNT OF CHANGE IN GRIPPING PRESSURE EXCEEDS PREDETERMINED VALUE
SS13a
COUNT NUMBER OF TIMES AMOUNT OF CHANGE EXCEEDS PREDETERMINED VALUE
SS23b
ACQUIRE SCREEN ORIENTATION
S31
DETERMINE OPERATION STATE
S44
SPECIFY OPTIMUM PLACEMENT AREA
S81
CORRECT PLACEMENT OF CONTROLLABLE OBJECT
S53
END

MOBILE INFORMATION TERMINAL AND OPERATION STATE DETERMINATION METHOD

TECHNICAL FIELD

The present invention relates to a mobile information terminal having a function to determine a user's operation state (one-handed or two-handed operation, etc.) from gripping features obtained when the mobile information terminal is gripped and an operation state determination method.

BACKGROUND ART

Mobile information terminals having a touch sensitive screen as a user interface have been coming into use in recent years. The user can intuitively operate the mobile information terminal with a touch sensitive screen by touching the screen with a finger or by sliding the finger on the screen. Many recent mobile information terminals incorporate an accelerometer, and those mobile information terminals can automatically switch the display orientation of the display screen in accordance of the direction of gravitational force sensed by the accelerometer. This allows the user to use the mobile information terminal in a variety of gripping states and operation states according to the circumstances. For example, the user may grip the mobile information terminal in the right hand and operate the terminal with the right fingers alone (right thumb mainly), may grip the mobile information terminal in the left hand and operate the terminal with the left fingers alone (left thumb mainly), may grip the mobile information terminal in the right hand and operate the terminal with the left fingers alone (left index finger mainly), and may grip the mobile information terminal in the left hand and operate the terminal with the right fingers alone (right index finger mainly). Moreover, the user may not grip the mobile information terminal but may place it on a stand and operate it with right fingers or left fingers, and may also grip the mobile information terminal in both hands and operate it with fingers of both hands (both thumbs mainly), for example.

Although the gripping states and operation states of the mobile information terminal vary as described above, conventional mobile information terminals cannot perform screen display suited to each gripping state and each operation state. For example, if the user grips the terminal in the right (left) hand and attempts to operate the touch sensitive screen with the right (left) thumb (this operation method will be referred to as one-handed operation), some areas of the touch sensitive screen, such as the top right corner, the bottom left corner, the top left corner, and the bottom right corner, become difficult to reach for the right (left) thumb. If an icon or link is displayed in those areas, it has been difficult for the user to touch the icon or link displayed in those areas while performing one-handed operation. For example, when the user of the mobile information terminal is going to operate the mobile information terminal, while standing in a moving train, the user would hold on to a strap or a rail with one hand so that he or she will not stagger and would perform one-handed operation of the mobile information terminal with the other hand.

If an icon or link the user wants to reach is displayed in an area that is difficult to reach for the right (left) thumb on the touch sensitive screen, the user should give up the operation until the next time the train stops and operate the mobile information terminal with both hands when the train has stopped, or should release the strap or rail temporarily in the moving train and operate the mobile information terminal

with both hands temporarily. If the train jolts while the user is not holding on to the strap or rail, the user may fall down. If this occurs in a crowded train, the user could bump into another passenger or could step on the foot of another passenger. The same inconvenience will occur when the user attempts to operate the mobile information terminal with one hand while carrying in the other hand a load that cannot be carried on his or her back. The user has to lower the load onto the ground and then operate the mobile information terminal.

A portable terminal in Patent Literature 1 utilizes a touch sensor (left sensor) disposed in the upper part of the left edge of the housing and a touch sensor (right sensor) disposed in the upper part of the right edge of the housing and solves the problems described above by determining whether the user's current holding state is left-handed operation, right-handed operation, or two-handed operation, using the states of thumbs detected by the left and right sensors and the detected state of the touch sensitive screen. When the detected states of the left sensor, right sensor, and touch sensitive screen are expressed by a circle (detection) or a cross (no detection), if the left and right sensors and the touch sensitive screen make no detection, for example, the state can be expressed as (left sensor, right sensor, touch sensitive screen)=(x, x, x). When the initial state **S1** is defined as a state in which the user is neither gripping the portable terminal nor touching the touch sensitive screen, the initial state **S1** can be expressed as (x, x, x). When a change from the initial state (x, x, x) to a state (O, x, x) is detected, it is determined that the left thumb is placed on the upper part of the left edge of the housing of the portable terminal, and the state shifts to a left-hand-holding state S**2**. When a change from the left-hand-holding state S**2** (O, x, x) to the state (x, x, x) is detected, it is determined that the thumb is moving to touch the touch sensitive screen, and the state shifts to a prior-to-left-handed-operation state S**3**. When a change from the prior-to-left-handed-operation state S**3** (x, x, x) to a state (x, x, O) is detected, it is determined that the thumb has touched the touch sensitive screen, and the state shifts to a subsequent-to-left-handed-operation state S**4**. When a change from the left-hand-holding state S**2** (O, x, x) to a state (O, x, O) is detected, it is determined that the terminal is held in the left hand and the touch sensitive screen is operated with a right finger, and the state changes to a left-hand-holding right-handed-operation state S**5**.

The same goes for the right hand. When a change from the initial state (x, x, x) to a state (x, O, x) is detected, it is determined that the right thumb is placed on the upper part of the right edge of the housing of the portable terminal, and the state shifts to a right-hand-holding state S**6**. When a change from the right-hand-holding state S**6** (x, O, x) to a state (x, x, x) is detected, it is determined that the thumb is moving to touch the touch sensitive screen, and the state shifts to a prior-to-right-handed-operation state S**7**. When a change from the prior-to-right-handed-operation state S**7** (x, x, x) to a state (x, x, O) is detected, it is determined that the thumb has touched the touch sensitive screen, and the state shifts to a subsequent-to-right-handed-operation state S**8**. When a change from the right-hand-holding state S**6** (x, O, x) to a state (x, O, O) is detected, it is determined that the terminal is held in the right hand and the touch sensitive screen is operated with a left finger, and the state shifts to a right-hand-holding left-handed-operation state S**9**. The terminal in Patent Literature 1 determines whether the user's current holding state is left-handed operation, right-handed operation, or two-handed operation, as described above, and repositions the control buttons on the touch sensitive screen so that they can be reached easily in any holding state.

Patent literature 1: Japanese Patent Application Laid Open No. 2009-169820

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

The portable terminal in Patent Literature 1, however, has the following problems in managing the user's current holding state. A first problem is that the portable terminal in Patent Literature 1 does not consider variability in the user's gripping manner among individuals. Accordingly, the portable terminal in Patent Literature 1 does not seem to increase the accuracy of determining the user's holding state above a certain level. For example, in the left-hand-holding right-handed-operation state S**5**, the user does not always place the left thumb on the upper part of the left edge of the housing of the portable terminal. The user may hold the portable terminal without placing the left thumb on the upper part of the left edge of the housing and may contort the thumb in such a direction that the tip of the thumb faces the user's face and may press the base of the thumb against the middle part of the left edge of the housing. If the user holds the lower part of the portable terminal, the left sensor disposed in the upper part of the left edge of the housing may not detect anything. Then, the portable terminal in Patent Literature 1 cannot determine the user's holding state correctly and cannot re-position the control buttons appropriately for each holding state.

A second problem is that a single detection state detected by the combination of the left sensor, right sensor, and touch sensitive screen represents a plurality of user's holding states, depending on the transition route. For example, the detected state (x, x, x) represents any holding state of the initial state S**1**, prior-to-left-handed-operation state S**3**, or prior-to-right-handed-operation state S**7**, depending on the transition route. For example, suppose that, although the portable terminal in Patent Literature 1 has determined that the detected state (x, x, x) represents the prior-to-left-handed-operation state S**3**, the determination is wrong, and the correct state is the prior-to-right-handed-operation state S**7**. Then, when the state shifts to a state (x, O, x), the portable terminal in Patent Literature 1 would misjudge the holding state after the shift is the subsequent-to-left-handed-operation state S**4**. In fact, since the prior-to-right-handed-operation state S**7** has shifted to a state (x, x, O), the correct determination is that the state has shifted to the subsequent-to-right-handed-operation state S**8**. From the misjudged subsequent-to-left-handed-operation state S**4**, further misjudgments will be repeated in determining the subsequent states.

In the portable terminal in Patent Literature 1, if a single misjudgment is made in the process of determining the user's holding state, subsequently determined states will be all wrong. Re-positioning control buttons on the touch sensitive screen in accordance with such misjudgment would be troublesome for the user and would result in increased inconvenience to the user. Therefore, it is an object of the present invention to provide a mobile information terminal that can determine with high accuracy whether the user's operation state is one-handed operation or two-handed operation, regardless of the variability in user's gripping features between individuals.

Means to Solve the Problems

A mobile information terminal of the present invention includes a pressure sensor array, a gripping pressure logger, a gripping pressure change point detection unit, and an operation state determination section. The gripping pressure change point detection unit includes a gripping pressure change amount calculation section. The gripping pressure logger records time-series changes in gripping pressure at each pressure sensor forming the pressure sensor array. The gripping pressure change amount calculation section acquires time-series changes in gripping pressure at each pressure sensor and determines whether the amount of change in gripping pressure per unit time exceeds a predetermined value at any pressure sensor. If the amount of change in gripping pressure per unit time exceeds the predetermined value at any pressure sensor, the operation state determination section determines that the operation state of the mobile information terminal of the user of the mobile information terminal is one-handed operation.

Effects of the Invention

The mobile information terminal according to the present invention can determine with high accuracy whether the user's operation state is one-handed operation or two-handed operation, regardless of variability in user's gripping features among individuals.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a view showing gripping features in two-handed operation with portrait display.

FIG. **1**B is a view showing gripping features in one-handed operation with portrait display.

FIG. **2**A is a view showing gripping features in two-handed operation with landscape display.

FIG. **2**B is a view showing gripping features in one-handed operation with landscape display.

FIG. **3**A is a view showing a state in which the controlling finger has been moved upward in one-handed operation.

FIG. **3**B is a view showing a state in which the controlling finger has been moved downward in one-handed operation.

FIG. **3**C is a view showing an area in which the gripping pressure changes when the controlling finger has been moved.

FIG. **4** is a view showing examples of pressure sensor arrays included in the portable terminals according to all embodiments.

FIG. **5**A to FIG. **5**D are views illustrating the relationship between the positions of gripping pressure change points and the operation state: Shown at FIG. **5**A is left-handed operation with portrait display; shown at FIG. **5**B is right-handed operation with portrait display; shown at FIG. **5**C is left-handed operation with landscape display; and shown at FIG. **5**D is right-handed operation with landscape display.

FIG. **6**A to FIG. **6**D are views illustrating the relationship among the positions of gripping pressure change points, screen orientation, and the operation state: Shown at FIG. **6**A is left-handed operation with portrait display, with the top of the screen shown at the top edge and the bottom of the screen shown at the bottom edge; shown at FIG. **6**B is right-handed operation with portrait display, with the top of the screen shown at the top edge and the bottom of the screen shown at the bottom edge; shown at FIG. **6**C is left-handed operation with landscape display, with the top of the screen shown at the right edge and the bottom of the screen shown at the left edge; and shown at FIG. **6**D is right-handed operation with landscape display, with the top of the screen shown at the right edge and the bottom of the screen shown at the left edge.

FIG. **7**A is a view showing an example of a controlling-finger movement range in left-handed operation when the screen orientation is unknown.

FIG. 7B is a view showing an example of a controlling-finger movement range in right-handed operation when the screen orientation is unknown.

FIG. 7C is a view showing an optimum placement area obtained by superimposing the controlling-finger movement ranges shown in FIGS. 7A and 7B.

FIG. 8A is a view showing an example of a controlling-finger movement range in left-handed operation when the screen orientation is known.

FIG. 8B is a view showing an optimum placement area obtained from the controlling-finger movement range shown in FIG. 8A.

FIG. 9A is a view showing an example of an optimum placement area when the gripping pressure change point is in a comparatively lower part.

FIG. 9B is a view showing an example of an optimum placement area when the gripping pressure change point is in a comparatively higher part.

FIG. 10A to FIG. 10D are views showing examples of a log recorded by a touch-sensitive-screen logger: Shown at FIG. 10A is a log of left-handed operation with portrait display; shown at FIG. 10B is a log of right-handed operation with portrait display; shown at FIG. 10C is a log of left-handed operation with landscape display; shown at FIG. 10D is a log of right-handed operation with landscape display.

FIG. 11A to FIG. 11C are views showing examples of optimum positions of controllable objects: Icons are shown at FIG. 11A; keys are shown at FIG. 11B; and links are shown at FIG. 11C.

FIG. 12 is a block diagram showing the configuration of a portable terminal according to a first embodiment.

FIG. 13 is a flowchart illustrating the operation of the portable terminal according to the first embodiment.

FIG. 14 is a block diagram showing the configuration of a portable terminal according to a second embodiment.

FIG. 15 is a flowchart illustrating the operation of the portable terminal according to the second embodiment.

FIG. 16 is a block diagram showing the configuration of a portable terminal according to a third embodiment.

FIG. 17 is a flowchart illustrating the operation of the portable terminal according to the third embodiment.

FIG. 18 is a block diagram showing the configuration of a portable terminal according to a fourth embodiment.

FIG. 19 is a flowchart illustrating the operation of the portable terminal according to the fourth embodiment.

FIG. 20 is a block diagram showing the configuration of a portable terminal according to a fifth embodiment.

FIG. 21 is a flowchart illustrating the operation of the portable terminal according to the fifth embodiment.

FIG. 22 is a block diagram showing the configuration of a portable terminal according to a sixth embodiment.

FIG. 23 is a flowchart illustrating the operation of the portable terminal according to the sixth embodiment.

FIG. 24 is a block diagram showing the configuration of a portable terminal according to a seventh embodiment.

FIG. 25 is a flowchart illustrating the operation of the portable terminal according to the seventh embodiment.

FIG. 26 is a block diagram showing the configuration of a portable terminal according to an eighth embodiment.

FIG. 27 is a flowchart illustrating the operation of the portable terminal according to the eighth embodiment.

BEST MODES FOR CARRYING OUT THE INVENTION

Now, embodiments of the present invention will be described in detail. Components having the same function are denoted by the same reference numerals, and duplicate descriptions will be omitted.

DESCRIPTION OF TERMS

Mobile Information Terminal

Specific examples of mobile information terminals include portable terminals, PDAs, portable gaming devices, electronic organizers, and electronic book readers. Besides the devices listed above, the mobile information terminal of the present invention can be any device that (1) is used in a gripped state and can acquire the gripping pressure while it is being used, (2) can be operated with one hand and with both hands, and (3) has a touch sensitive screen. In the description of embodiments, a portable terminal will be described in detail as an example.

One-Handed Operation, Two-Handed Operation

Using the right thumb for touch sensitive screen operation while gripping the mobile information terminal in the right hand and using the left thumb for touch sensitive screen operation while gripping the mobile information terminal in the left hand are both referred to as one-handed operation. Using left fingers for touch sensitive screen operation while gripping the mobile information terminal in the right hand and using right fingers for touch sensitive screen operation while gripping the mobile information terminal in the left hand are both referred to as two-handed operation.

Display Orientation, Screen Orientation

A display orientation is an orientation distinguished by whether the longer side of the rectangular display screen of the mobile information terminal is displayed as the vertical direction or the horizontal direction. A screen orientation is the top-to-bottom direction of the display screen of the mobile information terminal.

Portrait Display, Landscape Display

Displaying the longer side of the display screen of the mobile information terminal as the vertical direction is referred to as portrait display. Displaying the longer side of the display screen of the mobile information terminal as the horizontal direction is referred to as landscape display.

Controlling Finger

A finger that touches the touch sensitive screen of the mobile information terminal to control the mobile information terminal is referred to as a controlling finger.

Change Point

When the amount of change in gripping pressure per unit time, calculated for each pressure sensor by a gripping pressure change amount calculation section, which will be included in all the embodiments described later, exceeds a predetermined value, the position of the pressure sensor on the mobile information terminal will be referred to as a change point.

Change Frequency, Change Frequency Exceeding Point

A change frequency is the number of times counted by a change frequency counting section, which will be included in second, fourth, sixth, seventh, and eighth embodiments described later, each pressure sensor becomes a change point in a predetermined period of time. The position on the mobile information terminal of the pressure sensor at which the change frequency exceeds a predetermined frequency is referred to as a change frequency exceeding point.

Gripping Pressure Change Point

A gripping pressure change point is a general term for the change point and the change frequency exceeding point.

Controllable Object

User-controllable objects that are displayed on the display screen of the mobile information terminal are generically referred to as controllable objects. Specifically, the controllable objects include icons, links, keyboards, and the like.

[Difference in Gripping Features Between One-Handed Operation and Two-Handed Operation]

The mobile information terminal of the present invention is not limited to a portable terminal and can be a variety of devices, as described above. For ease of understanding, however, a portable terminal having a touch sensitive screen will be described as an example in all embodiments of the present invention. States of the user's left fingers when the user is gripping a portable terminal with a touch sensitive screen will be described with reference to FIGS. **1**A, **1**B, **2**A, **2**B, **3**A, **3**B, and **3**C. FIGS. **1**A and **1**B are views comparing gripping features between one-handed operation and two-handed operation, with portrait display. A portable terminal **2** has a nearly rectangular shape, and a rectangular display screen **2**D is disposed on one face. The touch sensitive screen is formed on the display screen **2**D but is not shown in the figures. FIGS. **2**A and **2**B are views comparing gripping features between one-handed operation and two-handed operation, with landscape display. FIGS. **3**A, **3**B, and **3**C are views illustrating a change in gripping pressure in one-handed operation. FIG. **1**A shows the state of the left hand when portrait display, left-hand gripping, and right-handed operation are performed. FIG. **1**B shows the state of the left hand when portrait display, left-hand gripping, and left-handed operation are performed.

Comparison between FIGS. **1**A and **1**B indicates that the gripping positions of the left index finger IND, middle finger MID, ring finger ANN, and little finger LIT do not differ greatly, but the position of the thumb differs greatly. When portrait display, left-hand gripping, and right-handed operation are performed, as shown in FIG. **1**A, the user's left thumb THM rests in a position outside the display screen **2**D, so that operation with a right finger will not be disturbed and the user can see the display screen **2**D easily. In contrast, when portrait display, left-hand gripping, and left-handed operation are performed, as shown in FIG. **1**B, the user's left thumb THM stands ready to touch a user-desired controllable object above the middle of the touch sensitive screen **2**D. The same goes for the landscape display (FIG. **2**A shows the state of the left hand when landscape display, left-hand gripping, and right-handed operation are performed, and FIG. **2**B shows the state of the left hand when landscape display, left-hand gripping, and left-handed operation are performed).

Features that are not found in two-handed operation can be seen in one-handed operation. FIG. **3**A is a view showing the limit of a counterclockwise movable range of the controlling finger (left thumb THM) when portrait display, left-hand gripping, and left-handed operation are performed. FIG. **3**B is a view showing the limit of a clockwise movable range of the controlling finger (left thumb THM) when portrait display, left-hand gripping, and left-handed operation are performed. Both FIGS. **3**A and **3**B show ranges where the user can move the left thumb easily as movable ranges. When the user can move the controlling finger (left thumb THM) as shown in FIGS. **3**A and **3**B, the tip of the controlling finger (left thumb THM) forms a circular locus around the point of contact between the base of the thumb and the edge of the portable terminal **2**, as shown in FIG. **3**C. The gripping pressure in the vicinity of the point of contact between the base of the left thumb and the edge of the portable terminal **2** (an elliptical area **2**R enclosed by a broken line in FIG. **3**C) varies from moment to moment while the controlling finger (left thumb THM) is contorting and touching the screen.

On the other hand, as indicated by FIGS. **1**A and **2**A, in two-handed operation, the gripping pressure does not change greatly in any areas of the portable terminal **2**, including the elliptical area **2**R enclosed by a broken line in FIG. **3**C. Accordingly, if a change in gripping pressure exceeding a predetermined value occurs in any area on the edges of the portable terminal **2**, it can be determined that the user is in the one-handed-operation state; and if a change in gripping pressure exceeding the predetermined value does not occur in any area on the edges of the portable terminal **2**, it can be determined that the user is in the two-handed-operation state. If the number of times changes in gripping pressure occur (change frequency) is large in any area on the edges of the portable terminal **2** in a predetermined period of time, it may be determined that the user is in the one-handed-operation state; and if the change frequency is small in any area of the edges of the portable terminal **2** in the predetermined period of time, it may be determined that the user is in the two-handed-operation state. According to the present invention, on the basis of the above-described points, it can be determined with high accuracy whether the user is in the one-handed-operation state or the two-handed-operation state.

Pressure Sensor Array **11**

A pressure sensor array **11** included in portable terminals **10**, **20**, **30**, **40**, **50**, **60**, **70** and **80** in all embodiments of the present invention, shown in FIGS. **12**, **14**, **16**, **18**, **20**, **22**, **24**, **26**, will be described next with reference to FIG. **4**. FIG. **4** is a view showing an example of the pressure sensor array **11** included in the portable terminals **10**, **20**, **30**, **40**, **50**, **60**, **70** and **80** (represented by the portable terminal **2**) in all the embodiments. FIG. **4** shows just an example and does not confine the position of the pressure sensor array **11** used in the present invention. However, since the pressure sensor array **11** used in the present invention needs to measure changes in gripping pressure at the position of contact between the base of the controlling finger (thumb) and an edge of the portable terminal **2** in one-handed operation, it is desirable that individual sensors be disposed at regular intervals at all edges of the portable terminal **2**. In the example shown in FIG. **4**, for example, the pressure sensor array **11** included in the portable terminal **2** includes a pressure sensor array U disposed on the upper edge of the portable terminal **2**, a pressure sensor array L disposed on the left edge of the portable terminal **2**, a pressure sensor array R disposed on the right edge of the portable terminal **2**, and a pressure sensor array B disposed on the bottom edge of the portable terminal **2**. The pressure sensor array U includes four pressure sensors **11**-U**1**, **11**-U**2**, **11**-U**3**, and **11**-U**4**. The pressure sensor array L includes seven pressure sensors **11**-L**1**, **11**-L**2**, **11**-L**3**, **11**-L**4**, **11**-L**5**, **11**-L**6**, and **11**-L**7**. The pressure sensor array R includes seven pressure sensors **11**-R**1**, **11**-R**2**, **11**-R**3**, **11**-R**4**, **11**-R**5**, **11**-R**6**, and **11**-R**7**. The pressure sensor array B includes four pressure sensors **11**-B**1**, **11**-B**2**, **11**-B**3**, and **11**-B**4**. Since the portable terminal **2** includes the pressure sensor array **11** in this manner, when the gripping pressure changes greatly in the elliptical area **2**R enclosed by a broken line in FIG. **3**C, described earlier, changes in gripping pressure can be observed by the pressure sensors **11**-L**5**, **11**-L**6**, and the like. In one-handed operation with right-hand gripping and right-handed operation, for example, changes in gripping pressure are observed by the pressure sensors **11**-R**5**, **11**-R**6**, and the like.

Operation of Gripping Pressure Logger **12**

A gripping pressure logger **12** included in the portable terminals **10**, **20**, **30**, **40**, **50**, **60**, **70** and **80** (represented by the portable terminal **2**) in all the embodiments of the present invention, shown in FIGS. **12**, **14**, **16**, **18**, **20**, **22**, **24**, and **26**, will be described next. The gripping pressure logger **12** records values observed by all the pressure sensors (**11**-U**1** to **11**-U**4**, **11**-L**1** to **11**-L**7**, **11**-R**1** to **11**-R**7**, and **11**-B**1** to **11**-B**4**) included in the pressure sensor array **11** as time-series data at each pressure sensor for use in determining the operation state, which will be described later.

Operation of Gripping Pressure Change Amount Calculation Section **13***a*

A gripping pressure change amount calculation section **13***a* included in the portable terminals **10**, **20**, **30**, **40**, **50**, **60**, **70** and **80** (represented by the portable terminal **2**) in all the embodiments of the present invention, shown in FIGS. **12**, **14**, **16**, **18**, **20**, **22**, **24**, and **26**, will be described next. One of the easiest ways of distinguishing between one-handed operation and two-handed operation from the time-series data of gripping pressure at each pressure sensor, recorded by the gripping pressure logger **12**, described above, is to determine whether an abrupt change in gripping pressure occurs at any pressure sensor. The gripping pressure change amount calculation section **13***a* is a component for detecting an abrupt change in gripping pressure. More specifically, the gripping pressure change amount calculation section **13***a* acquires time-series changes in gripping pressure at each sensor from the gripping pressure logger **12** and determines whether the amount of change in gripping pressure per unit time at each pressure sensor exceeds a predetermined value. The first derivative of the time-series data of gripping pressure can be used as the amount of change in gripping pressure per unit time.

Operation of Change Frequency Counting Section **23***b*

A change frequency counting section **23***b* included in the portable terminals **20**, **40**, **60**, **70**, and **80** (represented by the portable terminal **2**) in second, fourth, sixth, seventh, and eighth embodiments of the present invention, shown in FIGS. **14**, **18**, **22**, **24**, and **26**, will be described next. One method of distinguishing between one-handed operation and two-handed operation from the time-series data of gripping pressure recorded by the gripping pressure logger **12** at each pressure sensor can be based on the number of abrupt changes in gripping pressure observed at the pressure sensor in a predetermined period of time. The change frequency counting section **23***b* is a component for counting the number of abrupt changes in gripping pressure in the predetermined period of time. More specifically, the change frequency counting section **23***b* counts the number of times the amount of change in gripping pressure per unit time exceeds a predetermined value in each predetermined period of time.

Operation Principle of Operation State Determination Section **14** or **24**

The operation principle of an operation state determination section **14** or **24** included in the portable terminals **10**, **20**, **50**, and **60** (represented by the portable terminal **2**) in first, second, fifth, and sixth embodiments, shown in FIGS. **12**, **14**, **20**, and **22**, will be described next with reference to FIGS. **5**A to **5**D. FIGS. **5**A to **5**D are views illustrating the relationship between the position of a gripping pressure change point **2**G and the operation state. Black rectangles in FIGS. **5**A and **5**B represent pressure sensors that can observe a change in gripping pressure in one-handed operation when the display orientation of the display screen **2**D is portrait display. Black rectangles in FIGS. **5**C and **5**D represent pressure sensors that can observe a change in gripping pressure in one-handed operation when the display orientation is landscape display. For example, the black rectangles in FIG. **5**A represent the seven left pressure sensors (**11**-L**1** to **11**-L**7**), and the black rectangles in FIG. **5**B represent the seven right pressure sensors (**11**-R**1** to **11**-R**7**). At first sight, among the pressure sensors represented by the black rectangles, the pressure sensors **11**-L**1** and **11**-L**2**, for example, seem to be so high that the base of the controlling finger, that is, the thumb THM, will not touch them. However, when the user is using the portable terminal **2** with the screen orientation upside down (with the top of the screen displayed at the bottom of the figure) and when right-hand gripping and right-handed operation are performed, the pressure sensors **11**-L**1**, **11**-L**2**, and the like can touch the base of the controlling finger, that is, the right thumb THM. In the same way, when the user is using the portable terminal **2** with the screen orientation upside down (with the top of the screen displayed at the bottom of the figure) and when left-hand gripping and left-handed operation are performed, the pressure sensors **11**-R**1**, **11**-R**2**, and the like can touch the base of the controlling finger, that is, the left thumb THM. The same goes for landscape display shown in FIGS. **5**C and **5**D.

As described above, when the user is performing one-handed operation, a change in gripping pressure is always observed by some of the pressure sensors on the top, bottom, right, and left edges of the portable terminal **2**. In contrast, when the user is performing two-handed operation, no change in gripping pressure is observed by any of the pressure sensors on the top, bottom, right, and left edges of the portable terminal **2**. The operation state determination section **14** or **24** included in the portable terminals **10**, **20**, **50**, and **60** (FIGS. **12**, **14**, **20**, and **22**) in the first, second, fifth, and sixth embodiments determines that the operation state is one-handed operation when an amount of change in gripping pressure per unit time exceeds the predetermined value at any of the pressure sensors on the top, bottom, right, and left edges. The operation state determination section **14** or **24** determines that the operation state is two-handed operation when an amount of change in gripping pressure per unit time does not exceed the predetermined value at any of the pressure sensors on the top, bottom, right, and left edges.

Operation Principle of Operation State Determination Section **34** or **44**

The operation principle of an operation state determination section **34** or **44** included in the portable terminals **30**, **40**, **70**, and **80** (represented by the portable terminal **2**) in third, fourth, seventh, and eighth embodiments, shown in FIGS. **16**, **18**, **24**, and **26**, will be described next with reference to FIGS. **6**A to **6**D. FIGS. **6**A to **6**D are views illustrating the relationship among the position of a gripping pressure change point, the screen orientation, and the operation state. Black rectangles in FIG. **6**A represent pressure sensors that can observe a change in gripping pressure in a state of left-hand gripping and left-handed operation when the display orientation of the display screen **2**D is portrait display with the top of the screen displayed at the top of the figure. Black rectangles in FIG. **6**B represent pressure sensors that can observe a change in gripping pressure in a state of right-hand gripping and right-handed operation when the display orientation is portrait display with the top of the screen displayed at the top of the figure. Black rectangles in FIG. **6**C represent pressure sensors that can observe a change in gripping pressure in a state of left-hand gripping and left-handed operation when the display orientation is landscape display with the top of the screen displayed to the right of the figure. Black rectangles in FIG. **6**D represent pressure sensors that can observe a change in gripping pressure in a state of right-hand gripping and right-handed operation when the display orientation is landscape display with the top of the screen displayed to the right of the figure. As described earlier, when the user is performing two-handed operation, none of the pressure sensors on the top, bottom, right, and left edges of the portable terminal **2** observe a change in gripping pressure.

When the screen orientation (top-to-bottom direction) is known and when an edge that includes the position of the pressure sensor that has observed a change in gripping pressure (gripping pressure change point) is identified, as described above, the operation state determination section **34** or **44** in the portable terminal **30**, **40**, **70**, or **80** (FIG. **16**, **18**, **24**, or **26**) determines whether the user's operation state is one-handed or two-handed operation, in accordance with the two information items (the top-to-bottom direction and the position of the gripping pressure change point), and can further determine, in one-handed operation, whether it is left-hand gripping and left-handed operation or right-hand gripping and right-handed operation. More specifically, when the gripping pressure change point is on the right edge of the portable terminal **30**, **40**, **70**, or **80** with reference to the screen orientation (top-to-bottom direction), the operation state determination section **34** or **44** included in the portable terminal **30**, **40**, **70**, or **80** determines that the operation state is right-hand gripping and right-handed operation. When the gripping pressure change point is on the left edge of the portable terminal **30**, **40**, **70**, or **80** with reference to the screen orientation (top-to-bottom direction), the operation state is determined to be left-hand gripping and left-handed operation. When the gripping pressure change point is not found on any edge of the portable terminal **30**, **40**, **70**, or **80**, the operation state is determined to be two-handed operation.

Operation Principle of Placement Area Acquisition Section **51**

The operation principle of a placement area acquisition section **51** included in the portable terminal **50** or **60** (represented by the portable terminal **2**) in the fifth or sixth embodiment, shown in FIG. **20** or **22**, will be described next with reference to FIGS. **7**A, **7**B, and **7**C. FIGS. **7**A, **7**B, and **7**C are views showing examples of the placement area determined from a gripping pressure change point when the screen orientation (top-to-bottom direction) is not known. FIG. **7**A is a view showing an example of controllable range **2**F for the controlling finger (left thumb THM) in left-hand gripping and left-handed operation. The controllable range **2**F can be obtained by using the gripping pressure change point **2**G as a reference point. For example, the controllable range **2**F can be set as a fan-shaped area having a given width that is predetermined such that the controlling finger can easily touch the screen, within the counterclockwise and clockwise movable angle ranges of the controlling finger around the gripping pressure change point **2**G. The movable angle of the thumb THM is roughly 90°, with some variability between individuals. The radial width of the fan-shaped area should be set to an appropriate width such that an area that can be touched by small-handed people and an area that can be touched by large-handed people overlap, with variability in finger length among individuals taken into consideration.

FIG. **7**B shows an example in which the gripping pressure change point **2**G appears at the same position as shown in FIG. **7**A, the user uses the terminal upside down (with the top of the screen shown at the bottom of the figure), and right-hand gripping and right-handed operation are performed. Although the gripping pressure change point **2**G appears at the same position as shown in FIG. **7**A, a controllable range **2**F that can be obtained by using the gripping pressure change point **2**G as a reference point differs from that shown in FIG. **7**A. Whether the relationship between the gripping pressure change point **2**G and the controllable range **2**F obtained therefrom becomes the positional relationship shown in FIG. **7**A or the positional relationship shown in FIG. **7**B depends on the known screen orientation (top-to-bottom direction). If the function to determine the top-to-bottom direction is not provided, as in the portable terminal **50** or **60**, however, the range represented by polka dots shown in FIG. **7**C, including the standard controllable range **2**F determined as shown in FIG. **7**A and the standard controllable range **2**F determined as shown in FIG. **7**B, is set as a placement area **2**FA. The relative position of the gripping pressure change point with respect to the standard placement area is fixed. The placement area is stored in a placement area storage **52**, together with the relative position information thereof with respect to the gripping pressure change point before the portable terminal is shipped. The relative position information may be the coordinates of the center of gravity of the placement area and the coordinates of the gripping pressure change point or may also be the distance and angle between these two sets of coordinates on the coordinate system. If the position of the gripping pressure change point is acquired before the portable terminal has ever been used, even though the screen orientation (top-to-bottom direction) of the display screen **2**D is not known, an optimum placement area can be set by moving the placement area stored in the placement area storage **52** with respect to the acquired gripping pressure change point in accordance with the relative position information. The portable terminals **50** and **60** in the fifth and sixth embodiments do not have a screen orientation acquisition section **31** and do not acquire the screen orientation (top-to-bottom direction) beforehand, which will be described later in detail. Accordingly, the placement area acquisition section **51** of the portable terminals **50** and **60** in the fifth and sixth embodiments specifies an optimum placement area by moving the placement area **2**FA, represented by polka dots in FIG. **7**C, in accordance with the gripping pressure change point **2**G acquired from the operation state determination section **14** or **24**.

Operation Principle of Placement Area Acquisition Section **71**

The operation principle of a placement area acquisition section **71** included in the portable terminal **70** in the seventh embodiment shown in FIG. **24** will be described next with reference to FIGS. **8**A, **8**B, **9**A, and **9**B. FIGS. **8**A and **8**B are views showing an example of a placement area determined from a gripping pressure change point when the screen orientation (top-to-bottom direction) is known. FIGS. **9**A and **9**B are views showing an example of a change in the placement area, depending on the gripping pressure change point. FIG. **8**A is a view showing an example of the controllable range **2**F of the controlling finger (left thumb THM) in left-hand gripping and left-handed operation. The controllable range **2**F can be obtained with reference to the gripping pressure change point **2**G, as described above. The controllable range **2**F can be set as a fan-shaped area having a predetermined width such that the controlling finger can easily touch the screen, within the counterclockwise and clockwise movable angles of the controlling finger around the gripping pressure change point **2**G.

Since the screen orientation (top-to-bottom direction) is known for FIGS. **8**A and **8**B, the controllable range **2**F obtained in FIG. **8**A is directly set as the placement area **2**FA beforehand, like the area represented by polka dots in FIG. **8**B, and is stored in the placement area storage **52** together with the relative position information thereof with respect to the gripping pressure change point **2**G. The portable terminal **70** in the seventh embodiment includes the screen orientation acquisition section **31**, and the screen orientation acquisition section **31** can acquire the screen orientation (top-to-bottom direction), which will be described later in detail. Accordingly, the placement area acquisition section **71** of the portable terminal **70** in the seventh embodiment specifies the optimum placement area **2**FA, represented by polka dots, in accordance with the screen orientation (top-to-bottom direction) and the gripping pressure change point **2**G acquired from the operation state determination section **44**. Of course, since the relative positional relationship between the position of the gripping pressure change point **2**G and the controllable range **2**F (placement area **2**FA) is fixed, as shown in FIGS. **9**A and **9**B, a vertical movement of the gripping pressure change point **2**G moves the controllable range **2**F (placement area **2**FA) vertically. This goes for FIGS. **7**A, **7**B, and **7**C, as described earlier, and a vertical movement of the griping pressure change point **2**G moves the placement area **2**FA shown in FIG. **7**C vertically.

Operation Principle of Placement Area Acquisition Section **81**

The operation principle of a placement area acquisition section **81** included in the portable terminal **80** in the eighth embodiment shown in FIG. **26** will be described next with reference to FIGS. **10**A to **10**D. FIGS. **10**A to **10**D are views showing examples of a touch sensitive screen operation log recorded by a touch-sensitive-screen logger **82** included in the portable terminal **80** in the eighth embodiment. The touch-sensitive-screen logger **82** included in the portable terminal **80** in the eighth embodiment records a touch sensitive screen operation log for each combination of the operation state and the screen orientation in a time zone during which the combination of the operation state and the screen orientation remains unchanged. For example, FIG. **10**A shows an example of a touch sensitive screen operation log recorded by the touch-sensitive-screen logger **82** in a time zone during which the conditions of left-hand gripping, left-handed operation, and top of the screen being displayed at the top of the figure are satisfied, when the screen orientation acquisition section **31** acquires the screen orientation (top of the screen displayed at the top of the figure) and when the operation state determination section **44** determines that the operation state is left-hand gripping and left-handed operation. FIG. **10**B shows an example of a touch sensitive screen operation log recorded by the touch-sensitive-screen logger **82** in a time zone during which the conditions of right-hand gripping, right-handed operation, and the top of the screen being displayed at the top of the figure are satisfied, when the screen orientation acquisition section **31** acquires the screen orientation (top of the screen displayed at the top of the figure) and when the operation state determination section **44** determines that the operation state is right-hand gripping and right-handed operation. FIG. **10**C shows an example of a touch sensitive screen operation log recorded by the touch-sensitive-screen logger **82** in a time zone during which the conditions of left-hand gripping, left-handed operation, and the top of the screen being displayed to the right of the figure are satisfied, when the screen orientation acquisition section **31** acquires the screen orientation (top of the screen displayed to the right of the figure) and when the operation state determination section **44** determines that the operation state is left-hand gripping and left-handed operation. FIG. **10**D shows an example of a touch sensitive screen operation log recorded by the touch-sensitive-screen logger **82** in a time zone during which the conditions of right-hand gripping, right-handed operation, and the top of the screen being displayed to the right of the figure are satisfied, when the screen orientation acquisition section **31** acquires the screen orientation (top of the screen displayed to the right of the figure) and when the operation state determination section **44** determines that the operation state is right-hand gripping and right-handed operation.

In the figures, the touch sensitive screen operation log is represented by broken crosses. The size of the thumb is considered; a circular area (enclosed by a broken line in the figures) with a predetermined radius around a cross, which is a part of the touch sensitive screen operation log, is considered as an area included in the placement area; and a range containing all of the circular areas can be acquired as an optimum placement area **2**FA. Since the placement area acquisition section **81** in the portable terminal **80** of the eighth embodiment acquires the optimum placement area **2**FA on the basis of the touch sensitive screen operation log recorded by the touch-sensitive-screen logger **82**, the user's individual features can be considered, and user convenience can be improved further.

Operation of Object Placement Correcting Section **53**

The operation of an object placement correcting section **53** included in the portable terminals **50**, **60**, **70**, and **80** (represented by the portable terminal **2**) in the fifth, sixth, seventh, and eighth embodiments shown in FIGS. **20**, **22**, **24**, and **26** will be described next with reference to FIGS. **11**A, **11**B, and **11**C. The object placement correcting section **53** corrects the placement of a controllable object in accordance with the optimum placement area specified by the placement area acquisition section **51**, **71**, or **81**. The controllable object is a general term for objects that are displayed on the display screen **2**D of the portable terminal **2** and can be controlled by the user, as described earlier. More specifically, they are icons, links, keyboards, and the like. When areas enclosed by a broken line in FIGS. **11**A, **11**B, and **11**C are the optimum placement area **2**FA, user convenience is improved by moving icons that can be clicked on the display screen **2**D of the portable terminal **2** into the optimum placement area **2**FA, as shown in FIG. **11**A, for example. Re-disposing the displayed keys into the optimum placement area **2**FA on the display screen **2**D as shown in FIG. **11**B, for example, will be helpful for the user in preparing documents and searching for keywords. Re-positioning links on a page displayed by a web browser into the optimum placement area **2**FA as shown in FIG. **11**C, for example, allows the user to continue web browsing with less stress.

First Embodiment

The portable terminal **10** according to the first embodiment will be described in detail with reference to FIGS. **12** and **13**. FIG. **12** is a block diagram showing the configuration of the portable terminal **10** in this embodiment. FIG. **13** is a flowchart illustrating the operation of the portable terminal **10** in this embodiment. The portable terminal **10** in this embodiment includes the pressure sensor array **11**, the gripping pressure logger **12**, a gripping pressure change point detection unit **13**, and the operation state determination section **14**. The gripping pressure change point detection unit **13** includes the gripping pressure change amount calculation section **13***a*. The gripping pressure logger **12** records time-series changes in gripping pressure at each pressure sensor forming the pressure sensor array **11** (S**12**). The gripping pressure change amount calculation section **13***a* acquires the time-series changes in gripping pressure at each pressure sensor and determines whether the amount of change in gripping pressure per unit time at any pressure sensor exceeds the predetermined value (SS**13***a*). If the amount of change in gripping pressure per unit time at any pressure sensor exceeds the predetermined value, the operation state determination section **14** determines that the user's operation state of the portable terminal **10** is one-handed operation (S**14**). If the amount of change in gripping pressure per unit time at any pressure sensor does not exceed the predetermined value, the operation state determination section **14** determines that the user's operation state of the portable terminal **10** is two-handed operation (S**14**).

In this manner, the portable terminal **10** in this embodiment determines that the user's operation state is one-handed operation when the gripping pressure changes abruptly at any pressure sensor and determines that the user's operation state is two-handed operation when the gripping pressure does not change abruptly at any pressure sensor. Accordingly, it can be determined with high accuracy whether the user's operation state is one-handed operation or two-handed operation, regardless of variability in gripping features among individual users.

Second Embodiment

The portable terminal **20** according to the second embodiment, which has higher accuracy in determining the operation state than the portable terminal **10** of the first embodiment, will be described next in detail with reference to FIGS. **14** and **15**. FIG. **14** is a block diagram showing the configuration of the portable terminal **20** of this embodiment. FIG. **15** is a flowchart illustrating the operation of the portable terminal **20** of this embodiment. The portable terminal **20** of this embodiment includes the pressure sensor array **11**, the gripping pressure logger **12**, a gripping pressure change point detection unit **23**, and the operation state determination section **24**. The gripping pressure change point detection unit **23** includes the gripping pressure change amount calculation section **13**_a_ and the change frequency counting section **23**_b_. This embodiment differs from the first embodiment in that the gripping pressure change point detection unit **13** in the first embodiment is replaced by the gripping pressure change point detection unit **23** in this embodiment, the gripping pressure change point detection unit **23** includes the change frequency counting section **23**_b_, and the operation state determination section **14** in the first embodiment is replaced with the operation state determination section **24** in this embodiment.

The gripping pressure logger **12** records time-series changes in gripping pressure at each pressure sensor forming the pressure sensor array **11** (S**12**). The gripping pressure change amount calculation section **13**_a_ acquires the time-series changes in gripping pressure at each pressure sensor and determines whether the amount of change in gripping pressure per unit time at any pressure sensor exceeds the predetermined value (SS**13**_a_). The change frequency counting section **23**_b_ counts the number of times the amount of change in gripping pressure per unit time exceeds the predetermined value (change frequency) in each predetermined period of time (SS**23**_b_). The operation state determination section **24** determines that the user's operation state of the portable terminal **20** is one-handed operation in a time zone in which the change frequency counted at any pressure sensor exceeds the predetermined value (S**24**). The operation state determination section **24** determines that the user's operation state of the portable terminal **20** is two-handed operation in a time zone in which the change frequency counted at any pressure sensor does not exceed the predetermined value (S**24**).

In this manner, the operation state determination section **24** in the portable terminal **20** of this embodiment determines that the user's operation state is one-handed operation when the change frequency counted at any pressure sensor in the predetermined period of time exceeds the predetermined frequency, and determines that the user's operation state is two-handed operation when the change frequency counted at any pressure sensor in the predetermined period of time does not exceed the predetermined frequency. Therefore, the present embodiment provides the same advantages as the first embodiment and also provides higher accuracy in determining the operation state than the first embodiment. For example, when an impact is exerted in a part where the controlling finger is not placed and when a value indicated by a pressure sensor in the vicinity of the impact changes abruptly, the portable terminal **10** in the first embodiment could misjudge it as an operation of the controlling finger. In the portable terminal **20** in this embodiment, however, an abrupt change in value indicated by the pressure sensors is just counted as a single change, and the user's operation state is determined to be one-handed operation after the change frequency at any pressure sensor exceeds the predetermined frequency. The number of misjudgments like that described above can be reduced considerably. The portable terminal **20** in the second embodiment can determine the operation state with higher accuracy than the portable terminal **10** in the first embodiment.

Third Embodiment

The portable terminal **30** according to the third embodiment, which has an enhanced function of determining the operation state in comparison with the one in the portable terminal **10** of the first embodiment, will be described next in detail with reference to FIGS. **16** and **17**. FIG. **16** is a block diagram showing the configuration of the portable terminal **30** in this embodiment. FIG. **17** is a flowchart illustrating the operation of the portable terminal **30** in this embodiment. The portable terminal **30** in this embodiment includes the pressure sensor array **11**, the gripping pressure logger **12**, a gripping pressure change point detection unit **13**, the screen orientation acquisition section **31**, and the operation state determination section **34**. The gripping pressure change point detection unit **13** includes the gripping pressure change amount calculation section **13**_a_. This embodiment differs from the first embodiment in that the screen orientation acquisition section **31**, which is not included in the first embodiment, is included in this embodiment, and the operation state determination section **14** in the first embodiment is replaced with the operation state determination section **34** in this embodiment.

The gripping pressure logger **12** records time-series changes in gripping pressure at each pressure sensor forming the pressure sensor array **11** (S**12**). The gripping pressure change amount calculation section **13**_a_ acquires the time-series changes in gripping pressure at each pressure sensor and determines whether the amount of change in gripping pressure per unit time at any pressure sensor exceeds the predetermined value (SS**13**_a_). The screen orientation acquisition section **31** acquires the screen orientation (top-to-bottom direction) of the portable terminal **30** (S**31**). The operation state determination section **34** determines the user's operation state of the portable terminal **30** in accordance with the acquired screen orientation (top-to-bottom direction) and the position (change point) on the portable terminal **30** of the pressure sensor at which the amount of change in gripping pressure per unit time exceeds the predetermined value (S**34**).

In the portable terminal **30** of this embodiment, the screen orientation acquisition section **31** acquires the screen orientation (top-to-bottom direction), and the operation state determination section **34** can determine whether the user's operation state is left-hand gripping and left-handed operation, right-hand gripping and right-handed operation, or two-handed operation, by using two pieces of information (top-to-bottom direction and position of change point). Accordingly, besides the advantages of the first embodiment, enhanced operation state determination can be performed.

Fourth Embodiment

The portable terminal **40** according to the fourth embodiment, which has an enhanced function of determining the operation state in comparison with the one in the portable terminal **20** in the second embodiment, will be described next in detail with reference to FIGS. **18** and **19**. FIG. **18** is a block diagram showing the configuration of the portable terminal **40** in this embodiment. FIG. **19** is a flowchart illustrating the operation of the portable terminal **40** in this embodiment. The portable terminal **40** in this embodiment includes the pressure sensor array **11**, the gripping pressure logger **12**, a gripping pressure change point detection unit **23**, the screen orientation acquisition section **31**, and the operation state determination section **44**. The gripping pressure change point detection unit **23** includes the gripping pressure change amount calculation section **13***a* and the change frequency counting section **23***b*. This embodiment differs from the second embodiment in that the screen orientation acquisition section **31**, which is not included in the second embodiment, is included in this embodiment, and the operation state determination section **24** in the second embodiment is replaced with the operation state determination section **44** in this embodiment.

The gripping pressure logger **12** records time-series changes in gripping pressure at each pressure sensor forming the pressure sensor array **11** (S**12**). The gripping pressure change amount calculation section **13***a* acquires the time-series changes in gripping pressure at each pressure sensor and determines whether the amount of change in gripping pressure per unit time at any pressure sensor exceeds the predetermined value (SS**13***a*). The change frequency counting section **23***b* counts the number of times the amount of change in gripping pressure per unit time (change frequency) exceeds the predetermined value in each predetermined period of time (SS**23***b*). The screen orientation acquisition section **31** acquires the screen orientation (top-to-bottom direction) of the portable terminal **40** (S**31**). The operation state determination section **44** determines the user's operation state of the portable terminal **40** in accordance with the acquired screen orientation (top-to-bottom direction) and the position on the portable terminal **40** of the pressure sensor at which the change frequency exceeds the predetermined value (change frequency exceeding point) (S**44**).

In the portable terminal **40** of this embodiment, the screen orientation acquisition section **31** acquires the screen orientation (top-to-bottom direction), and the operation state determination section **44** can determine whether the user's operation state is left-hand gripping and left-handed operation, right-hand gripping and right-handed operation, or two-handed operation by using two pieces of information (top-to-bottom direction and the position of change frequency exceeding point). Accordingly, besides the advantages of the second embodiment, enhanced operation state determination can be performed.

Fifth Embodiment

The portable terminal **50** according to the fifth embodiment, obtained by adding an optimum placement area acquisition function and a controllable object placement correcting function based on an optimum placement area to the portable terminal **10** in the first embodiment, will be described next in detail with reference to FIGS. **20** and **21**. FIG. **20** is a block diagram showing the configuration of the portable terminal **50** in this embodiment. FIG. **21** is a flowchart illustrating the operation of the portable terminal **50** in this embodiment. The portable terminal **50** in this embodiment includes the pressure sensor array **11**, the gripping pressure logger **12**, a gripping pressure change point detection unit **13**, the operation state determination section **14**, the placement area acquisition section **51**, the placement area storage **52**, and the object placement correcting section **53**. The gripping pressure change point detection unit **13** includes the gripping pressure change amount calculation section **13***a*. This embodiment differs from the first embodiment in that the placement area acquisition section **51**, the placement area storage **52**, and the object placement correcting section **53**, which are not included in the first embodiment, are included. A description of components denoted by the same reference numerals as in the first embodiment will be omitted in this embodiment.

The placement area storage **52** stores in advance the shape of a placement area and the relative position information of a gripping pressure change point with respect to the placement area. The shape of the placement area can be the shape described in Operation principle of placement area acquisition section **51**, for example. The placement area acquisition section **51** acquires the gripping pressure change point acquired by the operation state determination section **14**, the placement area stored in the placement area storage **52**, and the relative position information between the placement area and the gripping pressure change point and specifies an optimum placement area (S**51**). The object placement correcting section **53** corrects the placement of one or a plurality of controllable objects in accordance with the specified optimum placement area (S**53**).

In the portable terminal **50** in this embodiment, the placement area acquisition section **51** specifies the optimum placement area and the object placement correcting section **53** corrects the placement of the controllable objects in accordance with the specified optimum placement area. Accordingly, besides the advantages of the first embodiment, since the controllable objects can always be placed at positions where the user can easily operate them, user convenience is improved further.

Sixth Embodiment

The portable terminal **60** according to the sixth embodiment, obtained by adding an optimum placement area acquisition function and a controllable object placement correcting function based on an optimum placement area to the portable terminal **20** in the second embodiment, will be described next in detail with reference to FIGS. **22** and **23**. FIG. **22** is a block diagram showing the configuration of the portable terminal **60** in this embodiment. FIG. **23** is a flowchart illustrating the operation of the portable terminal **60** in this embodiment. The portable terminal **60** in this embodiment includes the pressure sensor array **11**, the gripping pressure logger **12**, a gripping pressure change point detection unit **23**, the operation state determination section **24**, the placement area acquisition section **51**, the placement area storage **52**, and the object placement correcting section **53**. The gripping pressure change point detection unit **23** includes the gripping pressure change amount calculation section **13***a* and the change frequency counting section **23***b*. This embodiment differs from the second embodiment in that the placement area acquisition section **51**, the placement area storage **52**, and the object placement correcting section **53**, which are not included in the second embodiment, are included. A description of components denoted by the same reference numerals as in the second embodiment will be omitted in this embodiment.

The placement area storage **52** stores in advance the shape of the placement area **2**FA, which was described with reference to FIGS. **8**A and **8**B, and a gripping pressure change point **2**G. The shape of the placement area can be the shape described in Operation principle of placement area acquisition section **51**, for example. The placement area acquisition section **51** acquires the change frequency exceeding point acquired by the operation state determination section **24**, and the placement area and relative position information of the placement area with respect to the gripping pressure change point stored in the placement area storage **52**, and specifies an optimum placement area (S**51**). The object placement correcting section **53** corrects the placement of one or a plurality of controllable objects in accordance with the acquired optimum placement area (S**53**).

In the portable terminal **60** in this embodiment, the placement area acquisition section **51** specifies the optimum placement area, and the object placement correcting section **53** corrects the placement of the controllable objects in accordance with the specified optimum placement area. Accordingly, besides the advantages of the second embodiment, since the controllable objects can always be placed at positions where the user can easily operate them, user convenience is improved further.

Seventh Embodiment

Next, the portable terminal **70** according to the seventh embodiment, obtained by adding an optimum placement area specification function and a controllable object placement correcting function based on an optimum placement area to the portable terminal **40** in the fourth embodiment, will be described in detail with reference to FIGS. **24** and **25**. FIG. **24** is a block diagram showing the configuration of the portable terminal **70** in this embodiment. FIG. **25** is a flowchart illustrating the operation of the portable terminal **70** in this embodiment. The portable terminal **70** in this embodiment includes the pressure sensor array **11**, the gripping pressure logger **12**, a gripping pressure change point detection unit **23**, the screen orientation acquisition section **31**, the operation state determination section **44**, the placement area acquisition section **71**, the placement area storage **52**, and the object placement correcting section **53**. The gripping pressure change point detection unit **23** includes the gripping pressure change amount calculation section **13***a* and the change frequency counting section **23***b*. This embodiment differs from the fourth embodiment in that the placement area acquisition section **71**, the placement area storage **52**, and the object placement correcting section **53**, which are not included in the fourth embodiment, are included. A description of components denoted by the same reference numerals as in the fourth embodiment will be omitted in this embodiment.

The placement area storage **52** stores in advance the shape of a placement area and the relative position information between the placement area and a gripping pressure change point. The shape of the placement area can be the shape described in Operation principle of placement area acquisition section **71**, for example. The placement area acquisition section **71** acquires the change frequency exceeding point acquired by the operation state determination section **44**, and the placement area and the relative position information stored in the placement area storage **52**, and specifies an optimum placement area (S**71**). The object placement correcting section **53** corrects the placement of one or a plurality of controllable objects in accordance with the acquired optimum placement area (S**53**).

When the screen orientation is detected in step S**31** and one longer side of the screen is found to be the top, landscape display is used. Since the finger controllable range in one-handed operation is narrow, as shown in FIG. **2**B, it is natural to grip the portable terminal in one hand and operate it with the other hand, or to grip it in two hands and operate it with two hands. Therefore, the placement of the objects is not corrected.

In the portable terminal **70** of this embodiment, the placement area acquisition section **71** specifies the optimum placement area, and the object placement correcting section **53** corrects the placement of one or a plurality of controllable objects in accordance with the specified optimum placement area. Accordingly, besides the advantages of the fourth embodiment, since the controllable objects can always be placed at positions where the user can easily operate them, user convenience is improved further.

Eighth Embodiment

Next, the portable terminal **80** according to the eighth embodiment will be described in detail with reference to FIGS. **26** and **27**. In the portable terminal **80**, the placement of one or a plurality of controllable objects can be corrected while taking variability among individual users into consideration, by acquiring an optimum placement area from touch sensitive screen operation log, whereas, in the portable terminal **70** of the seventh embodiment, the optimum placement area is acquired from the placement area in the placement area storage **52**, FIG. **26** is a block diagram showing the configuration of the portable terminal **80** in this embodiment. FIG. **27** is a flowchart illustrating the operation of the portable terminal **80** in this embodiment. The portable terminal **80** in this embodiment includes the pressure sensor array **11**, the gripping pressure logger **12**, a gripping pressure change point detection unit **23**, the screen orientation acquisition section **31**, the operation state determination section **44**, the placement area acquisition section **81**, the touch-sensitive-screen logger **82**, and the object placement correcting section **53**. The gripping pressure change point detection unit **23** includes the gripping pressure change amount calculation section **13***a* and the change frequency counting section **23***b*. This embodiment differs from the seventh embodiment in that the placement area storage **52** in the seventh embodiment is replaced with the touch-sensitive-screen logger **82**, and the placement area acquisition section **71** in the seventh embodiment is replaced with the placement area acquisition section **81**. A description of components denoted by the same reference numerals as in the seventh embodiment will be omitted in this embodiment.

The touch-sensitive-screen logger **82** records the touch sensitive screen operation log of each operation state and each screen orientation in a period of time for which the operation state and the screen orientation (top-to-bottom direction) are remain unchanged. The placement area acquisition section **81** specifies an optimum placement area in accordance with the touch sensitive screen operation log recorded by the touch-sensitive-screen logger **82** (S**81**). As described in Operation principle of placement area acquisition section **81**, the placement area acquisition section **81** regards the circular area with the predetermined radius around each touch sensitive screen operation log as an area included in an optimum placement area while taking into consideration the size of the thumb, and can specify a range containing all of the circular areas as an optimum placement area.

In the portable terminal **80** of this embodiment, the touch-sensitive-screen logger **82** records the touch sensitive screen operation log, and the placement area acquisition section **81** specifies the optimum placement area in accordance with the recorded operation log. Accordingly, besides the advantages of the seventh embodiment, the placement of one or a plurality of controllable objects can be corrected while taking variability among individual users into consideration, and user convenience is improved further.

Each type of processing described above may be executed not only time-sequentially according to the order in the description but also in parallel or individually when necessary or according to the processing capability of each apparatus that executes the processing. Appropriate changes can be made to the above embodiments without departing from the scope of the present invention.

When the configurations described above are implemented by a computer, the processing details of the functions that should be provided by each apparatus are described in a program. When the program is executed by the computer, the processing functions are implemented on the computer.

The program containing the processing details can be recorded in a computer-readable recording medium. The computer-readable recording medium can be any type of medium, such as a magnetic recording device, an optical disc, a magneto-optical recording medium, or a semiconductor memory.

The program is distributed by selling, transferring, or lending a portable recording medium, such as a DVD or a CD-ROM, with the program recorded on it, for example. The program may also be distributed by storing the program in a storage unit of a server computer and transferring the program from the server computer to another computer through a network.

A computer that executes this type of program first stores the program recorded on a portable recording medium or the program transferred from the server computer in its storage unit. Then, the computer reads the program stored in its storage unit and executes processing in accordance with the read program. In a different program execution form, the computer may read the program directly from the portable recording medium and execute processing in accordance with the program, or the computer may execute processing in accordance with the program each time the computer receives the program transferred from the server computer. Alternatively, the above-described processing may be executed by a so-called application service provider (ASP) service, in which the processing functions are implemented just by giving program execution instructions and obtaining the results without transferring the program from the server computer to the computer. The program of this form includes information that is provided for use in processing by the computer and is treated equivalent to a program (something that is not a direct instruction to the computer but is data or the like that has characteristics that determine the processing executed by the computer).

In the description given above, each apparatus is implemented by executing the predetermined program on the computer, but at least a part of the processing details may be implemented by hardware.

What is claimed is:

1. A mobile information terminal provided with a pressure sensor array that acquires a gripping pressure distribution, the mobile information terminal comprising:

circuitry configured to function as

a gripping pressure logger adapted to record time-series changes in gripping pressure at each pressure sensor forming the pressure sensor array;

a gripping pressure change point detection unit comprising a gripping pressure change amount calculation section adapted to acquire time-series changes in gripping pressure at each pressure sensor and to determine whether the amount of change in gripping pressure per unit time exceeds a predetermined value at any pressure sensor; and

an operation state determination section adapted to determine that the operation state of the mobile information terminal of the user of the mobile information terminal is one-handed operation when the amount of change in gripping pressure per unit time exceeds the predetermined value at any pressure sensor, wherein

the gripping pressure change point detection unit further comprises a change frequency counting section adapted to count the number of times the amount of change in gripping pressure per unit time exceeds a predetermined value in each predetermined period of time, the number being referred to as a change frequency; and

the operation state determination section determines that the operation state of the mobile information terminal of the user of the mobile information terminal is one-handed operation in a period of time in which the change frequency exceeds a predetermined value.

2. The mobile information terminal according to claim **1**, wherein

the circuitry is further configured to function as a screen orientation acquisition section adapted to acquire the screen orientation of the mobile information terminal, and

the operation state determination section determines the operation state of the mobile information terminal of the user of the mobile information terminal in accordance with the acquired screen orientation and the position on the mobile information terminal of a pressure sensor at which the amount of change in gripping pressure per unit time exceeds the predetermined value, the position being referred to as a change point.

3. The mobile information terminal according to claim **1**, wherein

the circuitry is further configured to function as a screen orientation acquisition section adapted to acquire the screen orientation of the mobile information terminal, and

the operation state determination section determines the operation state of the mobile information terminal of the user of the mobile information terminal in the period of time, in accordance with the acquired screen orientation and the position on the mobile information terminal of a pressure sensor at which the change frequency exceeds a predetermined value, the position being referred to as a change frequency exceeding point.

4. The mobile information terminal according to claim **2**, wherein, when the change point is on the right edge of the mobile information terminal with reference to the screen orientation, the operation state determination section determines that the operation state of the mobile information terminal is right-hand gripping and right-handed operation, and when the change point is on the left edge of the mobile information terminal with reference to the screen orientation, the operation state determination section determines that the operation state of the mobile information terminal is left-hand gripping and left-handed operation.

5. The mobile information terminal according to claim **3**, wherein, when the change frequency exceeding point is on the right edge of the mobile information terminal with reference to the screen orientation, the operation state determination section determines that the operation state of the mobile information terminal in the period of time is right-hand gripping and right-handed operation, and when the change frequency exceeding point is on the left edge of the mobile information terminal with reference to the screen orientation, the operation state determination section determines that the operation state of the mobile information terminal in the period of time is left-hand gripping and left-handed operation.

6. An operation state determination method executed by a mobile information terminal provided with a pressure sensor array that acquires a gripping pressure distribution, the operation state determination method comprising:

a gripping pressure logging step of recording time-series changes in gripping pressure at each pressure sensor forming the pressure sensor array;

a gripping pressure change point detection step comprising a gripping pressure change amount calculation sub step of acquiring time-series changes in gripping pressure at each pressure sensor and of determining whether the amount of change in gripping pressure per unit time at any pressure sensor exceeds a predetermined value; and

an operation state determination step of determining that, when the amount of change in gripping pressure per unit time exceeds the predetermined value at any pressure sensor, the operation state of the mobile information terminal of the user of the mobile information terminal is one-handed operation, wherein

the gripping pressure change point detection step further comprises a change frequency counting step of counting the number of times the amount of change in gripping pressure per unit time exceeds the predetermined value in each predetermined period of time, the number being referred to as a change frequency; and

in the operation state determination step, the operation state of the mobile information terminal of the user of the mobile information terminal is determined to be one-handed operation in a period of time in which the change frequency exceeds a predetermined value.

7. The operation state determination method according to claim **6**, further comprising a screen orientation acquisition step of acquiring the screen orientation of the mobile information terminal;

wherein, in the operation state determination step, the operation state of the mobile information terminal of the user of the mobile information terminal is determined in accordance with the acquired screen orientation and the position in the mobile information terminal of a pressure sensor at which the amount of change in gripping pressure per unit time exceeds the predetermined value.

8. A non-transitory computer readable recording medium on which is recorded a program for causing a computer to execute the operation state determination method according to claim **6**.

9. A non-transitory computer readable recording medium on which is recorded a program for causing a computer to execute the operation state determination method according to claim **7**.

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